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Studies on the Ostracoda From Japan: I Subfamilies Leptocytherinae, N. Subfamilies, 'Toulminiinae', N. Subfamilies, and Cytherurinae, G. W. Muller.

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STUDIES ON THE OSTRACODA FROM JAPAN: I SUBFAMILIES LEPTOCYTHERINAE, N. SUBFAM., "TOULMINIINAE", N. SUBFAM., AND CYTHERURINAE G. W. MULLER

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ABSTRACT

This paper is part of a basic taxonomic study of Ostracoda found living in the sea surrounding Japan and as fossils in Pliocene and Miocene deposits in Japan. In this paper the subfamilies Leptocytherinae, n. subfam., "Toulminiinae", n. subfam. and Cytherurinae G. W. Muller are described. As a result of this study, it was found that Leptocytherinae have graditionally variable dentitition, but can be classified into four genera: (Leptocythere G. O. Sars, Callistocythere Ruggieri, Tanella Kingma, and Microcallistocythere, n. gen.) on the basis of the hinge structure. The Japanese samples studied contained 11 species of Callistocythere, one species of Tanella, and one species of Microcallistocythere. "Toulminiinae" include three genera, "Toulminia" Munsey, Neocythere, n. gen., and Arcacythere Hornibrook. The Japanese samples contained two species of "Toulminia" and two species of Neocythere. Cytherurinae can be classified into the following groups and subgroups on the basis of hinge structure: 1) Cytherura group (Cytherura G. O. Sars, Hemicytherura Elofson, Tetracytherura Ruggieri, Microcytherura G. W. Muller, and Howeina, n. gen.), 2) Cytheropteron group, 2a) Cytheropteron subgroup (Cytheropteron G. O. Sars, Aversovalva Hornibrook,

Kangarina Coryell and Fields, and Kobayashiella, n. gen.), 2b) Paracytheridea subgroup (Paracytheridea G. W. Muller, Paracytheropteron Ruggieri, and Pseudocytherura Duboysky), 3) Eocytheropteron group (Eocytheropteron Alexander, and Budaia Mehes), and 4) uncertain genera (Looneyella Peck, Orthonotacythere Alexander, Eucytherura G. W. Muller, and Paradoxorhyncha Chapman). The Japanese samples contained six species of Cytherura, one species of Howeina, three species of Hemicytherura, four species of Cytheropteron, and one species of Kobayashiella. Of the 34 species and subspecies described and illustrated in this paper, 31 are new.

INTRODUCTION

This report deals with the subfamilies Leptocytherinae, n. subfam., "Toulmininae" n. subfam. and Cytherurinae G. W. Muller, found living in the sea adjacent to Japan and as fossils in Pliocene and Miocene deposits in Japan.

The Leptocytherinae are among the most common ostracods found in the sea surrounding Japan and its vicinity. From this area, two leptocytherine ostracods have been described, Cythere crispata Brady (1868) and Cythere rectangulata Kajiyama (1912). The species described by Brady was based upon specimens collected from Hongkong Harbor by the Challenger Expedition. The species described by Kajiyama came from the beach near Misaki, Miura Peninsula, Japan. This subfamily is characterized by a hinge structure transitional from merodont to modified entomodont with containant[1] and by polyfurcate radial pore canals. In this paper, the type species of Leptocythere, 11 species of Callistocythere, one species of Tanella and one species of Microcallistocythere n. gen. are described or illustrated; all but three

[1]The term containant is here used for a groove of the keft valve, which contains or accomodates the dorsal edge of the opposite valve as typified by the subfamily Leptocytherinae. The containant opens anteriorly and posteriorly into the valve interior, or into anterior and posterior sockets which open interiorly.

of these species are new.

The "Toulmininae" are less common and less well known from the Japanese area; however, they occur very abundantly in some localities. Modified merodont hingement with teeth at the anterior and the posterior terminations of the median bar of the left valve characterizes this subfamily. I have had available for study Paleocene topotype specimens of "Toulminia" hyalokystis Munsey, the type species, and found that Japanese recent and Plio-Pleistocene specimens of "Toulminia" show striking resemblance to American Paleocene species, in spite of the difference in geologic age. Another group of Japanese "Toulminiinae" deviates from the type "Toulminia" in shell structure, and I here propose the name Neocythere for this group of Ostracoda. In this paper two species of "Toulminia" and two species of Neocythere are described as the new.

The Subfamily Cytherurinae is perhaps one of the most common in the world. Cytherurine ostracoda occur abundantly in the sea surrounding Japan, but they have not been studied previously in detail owing to their minute size. From this area Cytheropteron videns G. W. Muller and Cytheropteron mucronalatum Brady have been reported by Kajiyama (1913) and Brady (1880), respectively. The former species is actually a species of Hemicytherura, here described as Hemicytherura kajiyamai Hanai, n. sp.; the latter actually belongs to Brachycythere.

Our knowledge of Ostracoda is not great enough to clas-

sify and define the subfamily Cytherurinae with much certainty. In this paper, Cytherurinae are provisionally subdivided into groups. Six species of Cytherura, one species of Howeina, n. gen., three species of Hemicytherura, four species of Cytheropteron and one species of Kobayashiella n. gen. are described; the first three genera belong to the Cytherura group and the last two belong to the Cytheropteron group.

TYPES

All holotypes are deposited in the type collection of the Geological Institute, University of Tokyo, Tokyo, Japan, and paratypes are deposited in the H. V. Howe Collection, School of Geology, Louisiana State University, Baton Rouge, Louisiana, U. S. A.

LOCALITIES

Loc. 1. Recent beach sand from the shore behind an Imperial villa, Hayama-machi, Kanagawa Prefecture. Collected by T. Hanai.

Loc. 2. Recent beach sand from the shore behind the Mitsui Biological Station, Hamazaki-mura, Kamo-gun, Shizuoka Prefecture. Collected by T. Hanai.

Loc. 3. Recent beach sand from Toura, Hamazaki-mura Kamo-gun, Shizuoka Prefecture. Collected by T. Hanai.

Loc. 4. Recent beach sand from the shore about 1 km. N E of Akase railroad station, near Hiraiwa. Auda-mura, Uto-gun, Kumamoto Prefecture. Collected by

T. Hanai.

Loc. 5. Recent beach sand from the shore of Kashiwara about 200 m. S E of Dozanto-to, near Yamaga, Ashiyamachi, Onga-gun, Hukuoka Prefecture. Collected by T. Hanai.

Loc. 6. Upper Pliocene Setana formation in the valley of Toshibetsu-gawa, about 800 m. W. of Omagari, Toshibetsu-mura, Setana-gun, Hokkaido. Collected by T. Hanai. (= Asano, 1950, Loc. C-4).

Loc. 7. Upper Pliocene Setana formation at Kaigarazawa, about 500 m. W of Nishinosawa, Kuromatsunai-mura, Suttsu-gun, Hokkaido. Collected by T. Hanai. (= Asano, 1950, Loc. C-2).

Loc. 8. Upper Pliocene Sawane formation at the cliff at Mano Bay, Sawane-machi, Sado-gun, Niigata Prefecture. Collected by T. Uchio. (Loc. No. Sado Sawane 2B).

Loc. 9. Pliocene Cucullaea zone of the Hegi formation at a point west of Idenoue, Kawaminami-mura, Koyu-gun, Miyazaki Prefecture. Collected by T. Hanai.

Loc. 10. Miocene Suganuma sandstone conglomerate bed of the Oidawara tuffaceous mudstone in the valley east of Suganuma. Hiyoshi-mura, Toki-gun, Gifu Prefecture. Collected by T. Ogose.

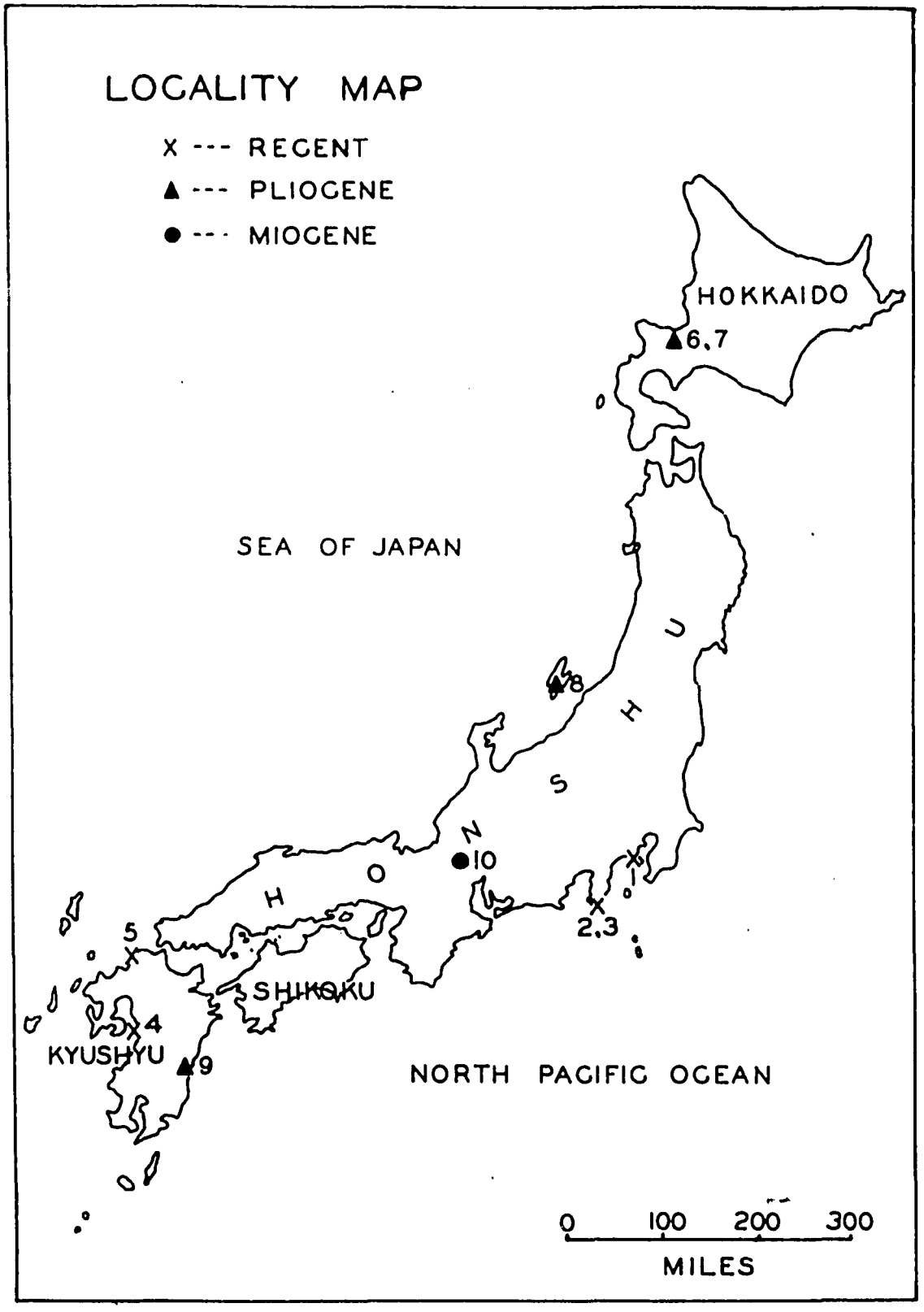
LOCALITY MAP
X --- REGENT
▲ --- PLIOGENE
● --- MIOGENE
HOKKAIDO
6.7
SEA OF JAPAN
HONSHU
8
10
2.3
5
SHIKOKU
4
KYUSHYU
9
NORTH PACIFIC OCEAN
0 100 200 300
MILES

Figure 1

SYSTEMATIC DESCRIPTION

Family CYTHERIDAE Baird, 1850

Subfamily LEPTOCYTHERINAE Hanai, n. subfam.

Type Genus: Leptocythere G. O. Sars, 1925

Diagnosis: Carapace elongate to subquadrangular in lateral outline, with a distinct posterior cardinal angle. Surface nearly smooth to deeply sculptured, some species with anterior and posteroventral marginal ridges. Marginal area broad with trifurcate or polyfurcate radial pore canals. Hinge modified entomodont. A groove below flange and above median bar of left valve receives or accomodates the median element of the right valve and opens into the anterior and posterior sockets. Anterior tooth and socket structure, and the twofold median element vary in different genera.

Description: Carapace comparatively small, elongate to subquadangular in lateral outline, with distinct posterocardinal angle. Surface punctate, reticulate, or with undulating ridges. Calcareous portion of inner lamella comparatively broad; radial pore canals moderately spaced, trifurcate or polyfurcate. Adductor muscle scars hard to distinguish, a row of four scars normally present. Eye

confluent. Hinge of right valve consists of anterior and posterior teeth with an intermediate shelf. Teeth usually faintly crenulated. Shelf socketed or pitted, usually having one or two prominent pits at anterior end. Hinge of left valve consists of anterior and posterior sockets and an intermediate ridge. Anterior socket sometimes obscure. Anterior and posterior sockets connected with a containant just above intermediate ridge. Ridge crenulated and having one or two prominent teeth at anterior end. Often the pits or sockets of the anterior end of the median element of right valve disappear, and the teeth of left valve become anti-slip teeth.[1]

Historical Review: For many years the leptocytherine ostracods were included in the genus Cythere O. F. Muller; in fact, some workers such as G. W. Muller considered them to be typical Cythere. In 1925, G. O. Sars proposed the generic name Leptocythere,[2] designating Cythere pellucida as genotype. He pointed out that this Leptocythere differed from the genus Cythere s.l. "by very narrow and elongate

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[1]The term anti-slip tooth was used by Kingma (1948) and Van den Bold (1950) for the tooth of Tanella, Javanella or Hemikrithe which prevents the anterior tooth of the opposite valve from slipping out of its socket. This type of tooth has no complementary socket in the opposite valve.

[2]In the original description, Sars (1925) used the name Leptocythera at the head of his description. However, in the description of his species and in the explanation of his plates, he used Leptocythere. It is obvious that Leptocythera is a typographical error. Therefore in accordance with Article 19 of the International Rules of Zoological Nomenclature, I will here use the name Leptocythere.

shape of the shell, the wholly confluent eyes and also by some other particularities in the structural details." He also included under Leptocythere all nine species which G. W. Muller (1894) had described from the Gulf of Naples under the name Cythere. Thus G. W. Muller's generic description is essentially a description of leptocytherine ostracods. In his description, Muller divided "Cythere" into two groups:

1) Shell of female less than twice as long as high (= Callistocythere)
2) Shell of female more than twice as long as high (= Leptocythere)

Rome (1942) followed G. W. Muller, rather than Sars, and in so doing divided the genus Cythere into the following three groups:

1) Section of Cythere lutea O. F. Muller
2) Section of Cythere lobiancoi G. W. Muller
3) Section of Cythere fabaeformis G. W. Muller

Of the above sections, 1) belongs to Cythere s. str., 2) and 3) belongs to Leptocytherinae. As already pointed out by Sars (1925) and Blake (1931), the confusion between Cythere and Leptocythere was due to the fact that the older work was based not so much on the type species of Cythere as on other species which later workers have assigned to various genera. Blake (1931) and Sylvester-Bradley (1941) gave detailed descriptions of the carapace of Cythere lutea, the genotype of Cythere. There can be no doubt that Leptocythere has a notably different carapace, not only in shape, but in

the character of the radial pore canals and hinge structure. These differences are too great for their retention in the same subfamily. I am, therefore, erecting a separate subfamily for Leptocythere and other genera which have characters closely similar.

In 1953, Ruggieri divided the genus Leptocythere, into two subgenera, Leptocythere s. str. and Callistocythere Ruggieri. The first group of Cythere species described by G. W. Muller (1894) and Rome's (1942) Cythere lobiancoi section correspond to Ruggieri's subgenus Callistocythere. Since 1925, when Sars proposed the generic name Leptocythere, many species have been described or reported under the name of Leptocythere by Klie (1929a, 1929b, 1933, 1938, 1939a, 1939b, 1942) Blake (1933), Dubowsky (1939), Elofson (1941), Triebel (1941,,1947) Pokorny (1943, 1944, 1945, 1952), Mehes (1941), Van den Bold (1946), Hessland (1946), Kingma (1949), Tressler and Smith (1948), Riggieri (1950, 1952, 1953), Swain and Peterson (1951; 1952), Hornibrook (1952a, 1952b, 1953), Kay (1954), Hartmann (1954), and Swain (1955). There are, however, still many leptocytherine species described before 1925 under the name Cythere, whose generic position has not been changed by later authors.

Remarks: The relatively small size of the carapace and the distinct angulation of the posterocardinal angle also serve to distinguish this subfamily. G. W. Muller has shown that the radial pore canals as well as some of the normal pore canals are connected with the touch-hairs and enclose

the nerves for perception. Therefore, polyfurcate radial pore canals (polyfurcate distribution pattern of nerves) is a relatively important taxonomic characteristic. According to Triebel (1954), complication of the radial pore canals of the marginal zone is a characteristic which appears at a phylogenetically late stage.

This subfamily includes the following genera:

Leptocythere Sars, 1925

Tanella Kingma, 1948

Callistocythere Ruggieri, 1953

Microcallistocythere Hanai, n. gen.

The following genera are similar in some details to the Leptocytherinae. However, in each case, I feel that they possess certain details of carapace structure which tend to exclude them from the subfamily Leptocytherinae.

Hemikrithe Van den Bold, 1950: The bifurcate radial pore canals, hinge structure, and posterocardinal angulation are similar to genera in the Leptocytherinae. However, the shape of the vestibule, mode of bifurcation of the radia pore canals, and structure of the hingement do not exactly fit with those of the leptocytherine Ostracoda.

Ilyocythere Klie, 1939: According to Klie (1939), this genus is anatomically close to Leptocythere: the shape of the carapace and the shell structure, however, are quite different.

Age: Age relationships in the subfamily Leptocytherinae

are at present difficult to determine with certainty. Triebel (1941) questionably assigned two specimens of ostracods from the Dogger of Germany to Leptocythere. Swain and Peterson (1951, 1952) described Leptocythere imlayi from the Upper Jurassic Sundance formation of Wyoming and Swift formation of Montana. Leptocytherine ostracods have not yet been reported from Cretaceous deposits. From the Tertiary, Hornibrook (1952, 1953) reported Eocene and Oligocene Leptocythere s.l. from New Zealand. Most of the described species of Leptocythere s.l. are from European Neogene deposits, but some are from North American and southeast and east Asian deposits of the same age. Many of these Neogene species belong to Callistocythere rather than to Leptocythere (s. str.). The genus Tanella has so far been reported only from Pliocene and later deposits in Sumatra.

Classification: The phylogenetic relationships in the subfamily Leptocytherinae are at present difficult to determine with certainty. However, the following morphological relationships in the dentition have been ascertained:

1) The simplest hingement found in Leptocyhterinae seems to be crenulated merodont with containant. (example: Microcallistocythere).

2) A modification is found in the Callistocythere littoralis and its allies, whose dentition is entomodont.

3) A further modification is the diminution of the second anterior tooth-and-socket structure of the intermediate element as exemplified by the Callistocythere japonica type.

4) Another modification is the disappearance of the intermediate element of the right valve from the Callistocythere type dentition, and the development of the anti-slip teeth from the anterior teeth of the intermediate element of the left valve, together with suppression of the crenulation of the intermediate element of right valve, as in Leptocythere (s. str.).

5) Finally, reduction of the anterior tooth-and-socket structure of both valves and development of a strong anti-slip tooth in the left valve is characteristic of the Tanella type.

The subfamily as described above has a rather gradationally variable dentition; however, all genera possess a posterior tooth-and-socket structure and a containant

Genus LEPTOCYTHERE Sars, 1925

Cythere auct. (part.)

1894 Cythere G. W. Muller (part.), pp. 350-352.

1925 Leptocythere Sars (part.), pp. 171-172.

1942 Cythere Rome (part.), pp. 18-19.

Leptocythere auct. (part.)[3]

1953 Leptocythere (Leptocythere) Ruggieri, pp. 95-96.

Type Species: Cythere pellucida Baird, 1850

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[3]Generic descriptions of the internal organs of Leptocythere s.l. are given by Klie (1929, 1938), Tresser and Smith (1948), and of the carapace are given by Van den Bold (1946), Kingma (1948) and Swain and Peterson (1951).

Diagnosis: Carapace elongate; surface nearly smooth to punctate. Vestibule moderate. Median hinge element of left valve has one tooth at the anterior end; corresponding socket of right valve is obscure.

Description: Carapace thin, oblong and elongate in outline; posterior cardinal angle distinct; ventral margin sinuous. Surface finely punctate. Calcareous portion of inner lamella broad at anterior and posteroventral ends. Vestibule well developed. Radial pore canals comparatively few and typically bifurcate or trifurcate. Hingement of right valve consists of slightly crenulate anterior and posterior teeth, and a long smooth or faintly crenulate intermediate bar. Posterior tooth stronger than anterior. Hingement of left valve consists of anterior and posterior sockets connected by a containant which received median bar of right valve. A long crenulate ridge lies just below the containant between the terminal sockets. Anti-slip-teeth present at anterior end of intermediate bar. An anti-slip-tooth-like projection is present in front of the anterior socket and just below the posterior socket.

Sexual dimorphism: Dimorphism is strong. The main differences between male and female carapace are 1) male forms are more elongate and narrower than female forms; 2) female forms have more rounded outline and are more tumid in the posterior area.

Remarks: The second group of G. W. Muller's (1894) classification of the genus Cythere, which is characterized

by the carapace of the female being about twice as long as high, and the Cythere fabaeformis section of Rome's (1942) classification, correspond to Leptocythere in a strict sense.

Leptocythere pellucida (Baird), 1850

1850 Cythere pellucida Baird, The Natural History of British Entomostraca, London (Roy. Soc.) p. 173, pl. 21, fig. 7.

1863 _____ _____ G. O. Sars, Beretning om en i Sommeren 1862 foretagen zoologisk Reise i Christianias og Trondhjems Stifter. Nyt Magazin for Naturvidenskaberne, vol. 12, pp. 250-251.

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1869 _____ _____ Brady and Robertson, Notes of a weeks' dredging in the west of Ireland. Ann. Mag. Nat. Hist., ser. 4, vol. 3, p. 363, pl. 19, figs. 10-12.

1874 _____ _____ Brady, Croossky and Robertson, A Monograph of the Post-Tertiary Entomostraca of Scotland including species from England and Ireland. Monograph Pal. Soc. London,

pp. 8, 28, 33, 34, 36, 37, 40, 42, 51, 60, 63, 76, 84, 87, 88, 90, 91, 92, 100, 101, 102, 103, 142-143, pl. 3, figs. 20-24.

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1912 _____ _____ G. W. Muller, Das Tierreich, Ostracoda 31 Lieferung. pp. 321-322.

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Non 1890 _____ _____ G. O. Sars, Oversigt af Norges Crustaceer, med forelobige Bemaerkninger over de nye elier mindre bejkendte Arter II, (Branchiopoda, Ostracoda, Cirripedia) Christiania Videnskabs-selskabs Forh. no. 1, pp. 19, 70.

Non 1891 _____ _____ Norman, Notes on the Marine

Crustacea Ostracoda of Norway. Ann. Mag. Nat. Hist., Ser. 6, vol. 7, pp. 110, 120.

Non 1905 _____ _____ Norman, Irish crustaces Ostracoda. Irish Nat., vol. 14, Dublin, p. 144.

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Non 1909 _____ _____ Hirschmann, Beitrag zur Kenntnis der Ostracodenfauna des Finnishen Meerbusens. Vorlaufige Mittelung. Meddelanden af Soc. pro Fauna et Flora Fannica II, 35, Helsingfors, p. 289.

Non 1912 _____ _____ Hirschmann, idem. Zweite Mitteilung. Acta Societatis pro Fauna et Flora Fennica, 36, no. 2, Helsingfors, p. 52, figs. 40, 41, 42 and 47.

1889 Cythere confusa Brady and Norman, A Monograph of the Marine and Freshwater Ostracoda of North Atlantic and of Northwestern Europe. Sect. 1, Ostracoda, Sci. Trans. Roy. Dublin Soc., 2, vol. 4, p. 127, pl. 14, figs. 16-18.

1890 _____ _____ G. O. Sars, Oversigt af Norges Crustaceer, med forelobige Bemaerkninger over de nye eller mindre bejkendte Arter II,

(Branchiopoda, Ostracoda, Cirripedia) Christiania Videnskabs-selskabs Forh. no. 1, pp. 19, 70.

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1909 _____ _____ Hirschmann, Beitrag zur Kenntnis der Ostracoden-fauna des Finnishen Meerbusens. Vorlaufige Mitteilung, Meddelanden af Soc. pro Fauna et Flora Fennica II, 35, Helsingfors, p. 289.

1912 _____ _____ Hirschmann, idem, Zweite Mitteilung. Acta Societalis pro Fauna et Flora Fennica 36, no. 2, Helsingfors, pp. 50-53, figs. 45-46.

1925 Leptocyhtere pellucida G. O. Sars, An account of the Crustacea of Norway. vol. 9, Ostracoda, pt. 9-10, pp. 172-173, pl. 79, fig. 1.

1929 _____ _____ Klie, Beitrag zur Kenntnis der Ostracoden der sudlichen und westlichen Ostsee, der festlandischen Nordseakuste und der Insel. Helgoland. Z. wiss. Zool., Leip-

zig, 134, pp. 278-279.

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and Durham, III, pp. 362, 367.

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Ostracoda, Copepoda, and Cirripedia. Proc. Roy. Phys. Soc. Edinburgh. XVI, 7, p. 280.

1901 Cythere confusa Anderson, Ett bidrag till Ostersjons djurgeograti. Ymer, IV, Stockholm, p. 368.

1902 _____ _____ Norman, Notes on the natural history of east Finmark. Ann. Mag. Hist. Ser. VII, vol. 10, p. 484.

1906 _____ _____ Scott, A catalogue of land, freshwater and marine Crustacea found in the basin of the river Forth and its estuary. II. Ostracoda, Copepoda and Cirripedia. Proc. Roy. Phys. Soc. Edinburgh. XVI: 7, p. 280.

1931 Leptocythere pellucida Muller, Die ostracoden des arktisehen Gebietes. Fauna Arctica VI, i, p. 28.

1938 _____ _____ Stephensen, Marine Ostracoda and Cladocera. Zool. of Iceland III, 32. Copenhagen and Reykjavik, p. 6

Remarks: Specimens for comparison in this paper came from Dog's Bay, County Galway, Ireland.

Genus CALLISTOCYTHERE Ruggieri, 1953

Cythere auct. (Part.).

1894 Cythere G. W. Muller (part.), pp. 350-352.

1925 Leptocythere Sars (part.), pp. 171-172.

1942 Cythere Rome (part.), pp. 18-19.

Leptocythere auct. (part.)

1953 Leptocythere (Callistocythere) Ruggieri, p. 99.

Type Species: Cythere littoralis G. W. Muller, 1894.

Diagnosis: Carapace elongate to subquadangular; surface sculptured by reticulation and undulating ridges. Vestibule poorly developed. More than two anterior terminal teeth of median hinge element of left valve definitely en enlarged; corresponding sockets of right valve distinct. Color usually yellow.

Description: Carapace thick, comparatively small, compressed laterally. In side view, subquadangular, posterior-cardinal angle distinct, dorsal margin nearly straight, ventral margin sinuous; anterior margin more broadly rounded than posterior. Surface reticulate or with undulating ridges; anterior and posterior marginal ridges well developed. Calcareous portion of inner lamella is broad in anterior and posteroventral regions. Line of concrescence almost coincides with inner margin. Radial pore canals polyfurcate and lobate, becoming serrate near the margin in weathered specimens. Hingement of the right valve consists of an anterior tooth, intermediate finely pitted shelf which has one or often more than one prominent socket or pit at its anterior termination, and a subquadrate posterior tooth; anterior and posterior teeth slightly crenulate. Hingement of left valve consists of anterior socket, intermediate crenulated ridge which has one or often more than one tooth of nearly equal size at its anterior termination, and a posterior socket; posterior socket opens interiorly. Ante-

rior and posterior sockets of left valve are connected through a containant which runs between flange and intermediate crenulate ridge. Tooth-like projections of an anti-slip nature are present in front of the anterior socket and below the posterior socket. The marginal contact areas of the two valves are fairly broad around the anterior and in the posteroventral region. The ventral sinuous margin of the right valve has a groove with a knob which is located on the outer wall of the groove, and is here called a "snap knob". The left valve has a selvage-like strong ridge with a "snap-pit" on the outer side of the ridge, which corresponds to the groove and "snap-knob" of the right valve.

Sexual dimorphism: The female form is larger and more quadangular than the male form in side view. In dorsal view, the female form appears broader than the male, especially in the posterocentral area. Sometimes the surface sculpture of the male form is somewhat stronger than that of the female form, especially in the posteroventral area. Cythere pavonia Brady has cup-shaped excavations or loculi on the posteroventral surface of the shell. This type of excavation is found in female forms of some Paleozoic ostracods. Triebel (1914) questionably assigned this species to the genus Leptocythere s.l., and is of the opinion that these excavations do not serve as a brood pouch. The same type of cup-shaped excavations are found in Callistocythere sp. which is described by Brady as Cythere crispata in the Challenger Report.

Comparison: The genera, Leptocythere and Callistocythere possess a very similar shell structure. However, in Leptocythere, the shell is comparatively thin, whereas in Callistocythere, strong deposition of shell material modifies and accelerates the surface ornamentation and the hinge structure. The following differences are recognizable:

Carapace: In general, Leptocythere has a more elongate and a thinner carapace than Callistocythere. The surface of Leptocythere is rather smooth or finely punctate, and the ornamentation is usually weak, whereas in Callistocythere, the surface of the carapace is strongly ornamented by reticulation or undulation of irregularly arranged ridges. Viewed from above, Leptocythere has a rather smooth posterocentral surface, whereas Callistocythere has often an angulated posterocentral surface owing to the strong development of posterior marginal ridges. The "snap knob" and pit structure on the ventral sinuous margin develops characteristically in Callistocythere; however, it is not always present in Leptocythere.

Hinge structure: Callistocythere has a well developed hinge structure in which both valves tightly articulate with each other. On the contrary, hingement of Leptocythere is fragile and the teeth and sockets do not articulate very well. The right valve of Callistocythere has one or more prominent pits just behind the anterior tooth, a feature not present in Leptocythere. These pits correspond to the knobs just behind the anterior socket of the left valve. In

Leptocythere the pits are lacking or obscure, because the teeth at the anterior termination of the intermediate ridge of the right valve fit under the median ridge of the left instead of into sockets, as in Callistocythere. The crenulation of the intermediate ridge is more distinct in Callistocythere than in Leptocythere. In Leptocythere, the line of concrescence runs irregularly near the middle of the marginal area and a definite vestibule is developed. However, in Callistocythere the line of concrescence runs close to the inner margin and often it coincides with the inner margin.

Ecology: Leptocytherine ostracods have been reported from shallow marine, brackish, and fresh water environments. (Klie, 1939). The European Leptocythere s. str. shows a certain preference for brackish water environments. Around Japan, Callistocythere is found in littoral sands. Leptocythere is reported from cold water, whereas, Callistocythere is predominant in warm water. (Ruggieri, 1953).

Remarks: The first group of G. W. Muller's classification (1894), which is represented by Cythere with the carapace of the female less than twice as long as high, and the Cythere lobiancoi section of Rome's classification (1942), correspond to Callistocythere. Pokorny (1952) observed in leptocytherine ostracods, a gradual transition of hingement from a merodont type to an amphidont type, because of the enlargement of the anterior terminal teeth of the crenulate ridge of the left valve. Callistocythere has dentition related to entomodont, but differs in having more than one

strong tooth, (usually two such teeth) at the anterior termination of the crenulate intermediate ridge of the left valve. In this character it is close to Xenocythere but differs from that genus in having a containant in the left valve, and in the development of anti-slip teeth. Callistocythere can be subdivided into two groups, C. littoralis group and C. japonica group's according to differences in the shape of the carapace and in the details of hinge structure.

1. Callistocythere littoralis group

Carapace comparatively thick, subquadrangular in lateral outline. Ornamentation strong. The two or more anterior terminal teeth of the left valve and corresponding sockets of the right valve definitely enlarged. Vestibule poorly developed. Color yellow.

Callistocythere sp.

1880 Cythere crispata G. S. Brady, Challenger Report, Zoology, vol. 1, pp. 72-73, pl. XIV, figs. 8a-d.

Remarks: Cythere crispata Brady (1868) was originally described from Tenodos in the eastern Mediterranean. Its carapace has a surface which is "exceedingly irregular, marked with waved rounded and irregularly felxuous ridges." In Brady's Challenger Report, (1880) another specimen was figured from the Pacific as C. crispata. It came from either Port Jackson, Booby Island, or Hongkong Harbor. Brady indicated that this Pacific form is characterized by a reticulate shell surface which was "sculptured all over with closely-set angular excavations of irregular form and size." It is also

noteworthy that the form figured shows crescentic excavations on the ventral surface of the carapace. In 1890 Brady described C. crenata from Noumea, New Caledonia, and from other south Pacific localities and placed the forms he had previously reported from Port Jackson, Booby Island, and Hongkong in the synonomy of this new species. However, the type of C. crenata as figured by Brady shows a more or less flexuous surface, "marked with undulated ridges very variable in their development enclosing between them fossae of irregular shape and size." From this it will be seen that the species figured in the Challenger Report was different from the Mediterranean C. crispata Brady, and also different from the later C. crenata Brady in both surface ornamentation and outline. None of the forms figured by Brady have been encountered in my Japanese collections.

Callistocythere rectangulata (Kajiyama), 1913

1913 Cythere rectangulata Kajiyama, Dobutsugaku-zasshi(Zool. Mag.) vol. 25, no. 291, pp. 10-11, pl. 1, figs. 56-60.

Remarks: This species was described by Kajiyama from Misaki, Miura Peninsula, Kanagawa Perfecture, Japan. The original description is written in Japanese. The species is characterized by the prominent posteroventral ridge which continues to the anteroventral area, runs along the ventral margin, projects below the posteroventral margin, turns upward near the posterior end, makes three projections in the posterior area and ends in the posterodorsal area.

Callistocythere nipponica Hanai, n. sp.

Pl. I, Figs. 1a, b; Pl. IV, Fig. 4.

Description: Carapace oblong to subquadrangular in side view; highest at anterior cardinal angle; anterior outline obliquely rounded with about 10 small projections at end of radial pore canals, especially in lower half of anterior margin; dorsal outline gently convex and sloping toward posterior; ventral outline slightly sinuous near middle; posterior outline truncated, rounded below. Most of surface sculptured by coarse and deep reticulations, which are rather uniformly developed except immediately below and behind the place of muscle-attachment where one or more cross ridges appear to be lacking. A row of small projections along anterior contact margin becomes a ridge ventrally which runs along the ventral contact margin, slightly digresses from the margin in the ventral sinuous area, curves around the posterior margin and ends near the posterocardinal angle. A second anterior marginal rim starts at the anteroventral margin, and runs upward along the anterior margin, but digresses from the margin in the upper half and ends near the anterocardinal angle. A dorsoposterior marginal ridge starts behind the eye spot and is sufficiently high to obscure the straight hinge line; it curves around the upper two-thirds of the posterior end before dying out where the two dorsoposterior and ventroposterior ridges fuse side by side. A second posterior ridge starts downward from just in front of the posterior cardinal area and then curves to parallel the posterior marginal rim. It terminates in the posteroventral area where it connects

with the reticulate pattern of the surface. In dorsal view the carapace falsely appears to be constricted immediately behind the area of muscle-attachment. This appearance is due to the failure of certain reticulate ridges to develop in this immediate area. Anterior and posterior marginal ridges give slight angulation to the dorsal view. The dorsal surface of each valve is flattened. These flat surfaces slop toward each other so as to make a V-shaped through along the hinge line. Each flattened area is corssed by about four transverse ridges which are slightly oblique to the hinge line. In end view, the carapace is subovate, broadest at a point a little below mid-height. Ventral surface slightly flattened. Eye spot small. The line of concrescense almost coincides with the inner margin, and the vestibule is extremely narrow. The duplicature is wide at anterior and posteroventral regions. Radial pore canals moderately numerous and polyfurcate outwardly. At the anteroventral margin, they extend to each marginal projection where the polyfurcations are most distinctive. Some branches of the radial pore canals terminate between the margin of the carapace and the marginal rim. The normal pore canals are few in number and relatively large in size, and are scattered over the surface between reticulations. The muscle-scar pattern is located slightly lower than center, below and behind the central pit, and consists of at least four slightly elongated, closely spaced scars. Each scar is raised as a tubercle on the inside of the valve.

The selvage is prominent in both valves, especially strong in the ventral sinuous margin. In the left valve, the selvage serves as a ridge which is a complement to the flange groove of the right valve. On the contrary, in the right valve the selvage serves as an inner wall of the flange groove. In the ventral sinuous part of the right valve, the flange has a "snap knob". In the left a corresponding "snap pit" cuts the flange, reaches to the selvage, and opens outwardly. The hinge of the right valve consists of an anterior faintly crenulate tooth, two sockets, a long and minutely pitted intermediate ridge, and a slightly crenulate posterior tooth. The intermediate ridge is almost straight, makes an angle of about 155° with anterior teeth and two sockets, and an angle of about 145° with the posterior tooth. The hinge of the left valve consists of an anterior socket, two teeth, an intermediate crenulate ridge and a posterior socket. The anterior and posterior sockets open to the interior. Between the intermediate ridge and the flange, there develops a containant which connects the anterior and posterior sockets.

Dimensions: Holotype (complete carapace) length 0.65 mm., height 0.36 mm., thickness 0.30 mm.; paratype (complete carapace) length 0.62 mm., height 0.35 mm., thickness 0.30 mm.

Occurrence: All types were collected from Recent beach sand from Loc. 1, where it is rare.

Remarks: This species shows some relation to Callisto-

cythere sp. described by Brady (1880) as Cythere crispata (Brady 1880, pp. 72-73, pl. XIV, figs. 8 s-d). However, the distinct anterior marginal rims, the posteroventral ridge, and the surface ornamentation at the ventral part of the valves in this species is quite different from those in the latter species. Furthermore, Callistocythere nipponica Hanai does not possess the small loculi-like excavations which are characteristic of Brady's species.

Callistocythere reticulata Hanai, n. sp.

Pl. II, Figs. 2 a-d.

Description: Carapace oblong, subreniform, highest at the anterior cardinal angle. Anterior margin obliquely rounded, with about five small projections at termination. of radial pore canals, especially along lower half of anterior margin. Dorsal margin gently arched and inclined backward. Posterior cardinal angulation distinct. Posterior margin truncated above, rounded below. Ventral margin moderately sinuous near middle. Surface sculptured by dense and deep reticulations. Anterior marginal ridge weak; beginning at the middle of the anterior margin, it runs along the anteroventral margin to the ventral sinuation. The second anterior marginal ridge runs from the eye spot to the anterocentral area. A dorsoposterior marginal ridge starts behind the eye spot and is sufficiently high to obscure the hinge line. It reaches to the lower part of the posterior margin. The second posterior ridge runs from the posterodorsal area, is prominent in the posteroventral

area, and ends in the ventral sinuous margin. In the dorsal view, the carapace is elongate ovate, widest in the posterocentral area, but slightly compressed in the central muscle-scar area. The troughs between the first and second anterior marginal ridges, and the first and second posterior marginal ridges are prominent in dorsal view. Dorsal surface of the valves forms a V-shaped trough along the hinge line. In end view the carapace is subovate. Sexual dimorphism fairly strong; male form slightly narrower in side view, and more compressed in dorsal view, especially at the posterocentral area.

Dimensions: Holotype (male complete carapace) length 0.52 mm., height 0.27 mm., thickness 0.20 mm., allotype (female complete carapace) length 0.53 mm., height 0.30 mm., thickness 0.25 mm.; paratype (male complete carapace) length 0.53 mm., height 0.27 mm., thickness 0.21 mm.; (female complete carapace) length 0.56 mm., height 0.31 mm., thickness 0.25 mm.

Occurrence: All type specimens were collected from Recent beach sand from Loc. 1, where they are common.

Remarks: This species closely resembles Callistocythere nipponicea Hanai; it is however, smaller and differs in lateral outline. The reticulation is denser in this species and the pattern of the marginal ridges is quite different from Callistocythere nipponica, especially in the second posterior marginal ridge. Among the European species, Leptocythere bacesoci (Rome) from Recent

Quaternary deposits of Monaco and Italy is closely related to this species. This species has coarser reticulations than the European species.

Callistocythere alata Hanai, n. sp.

Pl. I, Figs. 4a,b; Pl. IV, Fig. 5.

Description: Carapace oblong in side view, somewhat tumid, highest at anterocardinal angle. Anterior margin obliquely rounded, with about eight small projections at terminations of radial pore canals, especially along lower half of anterior margin. Dorsal margin slightly arched, sloping gently toward posterior. Posterior cardinal angle distinct in left valve, obscure in right valve. Posterior margin rounded below. Ventral margin very slightly sinuous near middle. Surface sculptured by coarse and deep reticulations. The second anterior marginal ridge begins at the anterior cardinal angle, digresses from the middle of the anterior margin, then follows the anterior margin closely to the ventral margin, where it connects with the prominent ventral marginal ridge. The second posterior marginal ridge branches from the first posterior marginal ridge near the posterior cardinal angle and curves downward almost to the ventral margin. A straight ventral ridge begins at the junction with the anterior margin. It runs backward away from the ventral contact margin and terminates in a spine, which gives an alate appearance in side view. In dorsal view the carapace is seen to be widest in the posterocentral area. The flat dorsal surface of both

valves makes a V-shaped trough along the hinge-line. The trough is deepest at the posterior end. The posterior marginal rim and the second posterior marginal ridge projections near the posterior end when viewed from above. Viewed from in front the carapace is seen to be subovate in the anterior half and subpentagonal in the posterior half because of the ventrolateral ridges. The marginal area, adductor muscle-scar patterns and hinge structure are similar to those of the other species of this genus. Sexual dimorphism is weak; the carapace of the female form is somewhat larger than that of the male form, and is widest at the posterocentral area, whereas the male form is widest at the central area.

Dimensions: Holotype (male complete carapace) length 0.57 mm., height 0.30 mm., thickness 0.27 mm.; allotype (female complete carapace) length 0.59 mm., height 0.33 mm., thickness 0.29 mm.; paratype (female complete carapace) length 0.59 mm., height 0.33 mm., thickness 0.29 mm.

Occurrence: Holotype and allotype specimens were collected from Recent beach sand at Loc. 2. (coll. by Hanai, 14/1 1953) Paratype specimens were collected from Recent beach sand at Loc. 1, where it is rare.

Remarks: The straight ventral ridge with the spine at its posterior termination characterizes this species. It has some resemblance to Callistocythere nipponica Hanai. However, in its coarser reticulation and straight

ventral ridge, it clearly differs from the latter species.

Callistocythere rugosa Hanai, n. sp.

Pl. II, Figs. 3 a-d.

Description: Carapace small, oblong, subreniform, highest at the anterior cardinal angle; anterior margin obliquely rounded; terminations of the radial pore canals form about seven slight projections along the anterior margin. Dorsal margin straight, posterior dorsal slope somewhat concave. Ventral margin sinuous near middle. Surface sculptured by numerous flexures, two longitudinal trends being the most prominent. Reticulation on a small scale develops in the anterodorsal, anteroventral, posterodorsal, and posteroventral areas. The second posteroventral margin ridge is prominent and runs from the posterior part of the dorsal margin to the ventral sinuous margin, making a strong posterior angulation in dorsal view. The second anterior marginal ridge is strong and runs from the upper part of the anterior margin to the anteroventral area. The marginal area and muscle-scar pattern are similar to those of Callistocythere nipponica Hanai. The hinge is likewise similar but is more strongly arched in Callistocythere nipponica. In the dorsal view, the carapace appears compressed and irregularly subhexagonal with both the anterior marginal ridge and the posteroventral marginal ridge projected. In the end view, the carapace is subhexagonal in outline.

Sexual dimorphism is very slight. The female form is

thicker in ventral view and slightly larger than the male form, and is quadangular in shape.

Dimensions: Holotype (male complete carapace) length 0.46 mm., height 0.25 mm., thickness 0.17 mm.; allotype (female complete carapace) length 0.45 mm., height 0.25 mm., thickness 0.20 mm.; paratype (male complete carapace) length 0.44 mm., height 0.24 mm., thickness 0.17 mm.; (female complete carapace) length 0.47 mm., height 0.27 mm., thickness 0.21 mm.

Occurrence: All type specimens were collected from Recent beach sand from Loc. 1, where they are common. (Coll. by T. Hanai, 30/11, 1952).

Remarks: This species is closely related to Cythere crenata Brady (Brady 1890, vol. 35, pt. II, no. 14, pp. 497-498, pl. 2 figs. 35-36). However, Brady's species has one row of undulating ridges disposed more or less longitudinally while my Japanese species has two longitudinal rows of ridges. Brady's species also lacks the reticulations of Callistocythere rugosa.

Callistocythere undata Hanai, n. sp.

Pl. II, Figs. 1 a-d.

Description: Carapace thick, small, subquadrangular in side view, highest at anterior cardinal angle; anterior margin broadly and obliquely rounded with about five small projections along the anteroventral margin. Ventral margin sinuous at middle. Posterior margin truncated above and rounded below. Dorsal margin slightly arched. The

posterodorsal complex of strong surface ornamentation slightly projects over the dorsal margin is side view. Posterocardinal angle distinct.

Surface ornamented by strong, large and blunt ridges, which have a tendency to run more or less vertically in the dorsal area, and transversely in the ventral area. The anterior marginal ridge is strong. It begins near the eye spot and continues to the anteroventral margin. A strong ridge occurs at the anterocardinal angle, runs down through the eye tubercle, and joins with the anterior marginal ridge at the middle of the anterior margin. The posteroventral margin is especially strong at the posteroventral margin. The second posterior ridge is strongest in the posteroventral area. The posterior hinge tubercle is stronger in the left valve than in the right. The characters of the marginal area, muscle-scar pattern and hinge structure are similar to the other species of this genus. Viewed from the inside the carapace is shallow; in dorsal view, it is compressed and broadest at the ventral projection of the second posterior ridge. The dorsal surface of the valves makes a small V-shaped trough. In anterior view, the carapace appears almost square owing to the blunt ventral projection of the second posteroventral ridge and the posterodorsal complex of surface ornamentations. Sexual dimorphism is not very strong. The male form is more slender than the female form.

Dimensions: Holotype (male complete carapace) length

0.50 mm., height 0.28 mm., thickness 0.20 mm.; allotype (female complete carapace) length 0.50 mm., height 0.29 mm., thickness 0.21 mm.; paratype (male complete carapace) length 0.47 mm., height 0.27 mm., thickness 0.19 mm.; (female complete carapace) length 0.51 mm., height 0.30 mm., thickness 0.22 mm.;

Occurrence: All type specimens were collected from Recent beach sand at Loc. 1, where they are common. (Coll. by Hanai, 3/11, 1952).

Remarks: The quadrangular outline and blunt undulated ridges of this species show some resemblance to those of Callistocythere undulatifacialis Hanai. However, in detail, this species differs somewhat from Callistocythere undulatifacialis Hanai in surface ornamentation, especially in the second posterior marginal ridge, and in lacking reticulations, as well as being smaller.

Callistocythere hayamensis Hanai, n. sp.

Pl. I, Figs. 2 a-d.

Description: Carapace large, subquadrangular in side view. Anterior margin obliquely rounded, with about six small projections at the terminations of the radial pore canals along the lower half of the anterior margin. Ventral and dorsal margin nearly parallel. Ventral margin slightly sinuous in front of middle. Posterior cardinal angle distinct. Posterior margin rounded below. Surface sculptured by irregular and incomplete reticulations not well developed in marginal area. Reticulate surface

slightly undulated. Weak ventral marginal ridge runs along anterior half of ventral margin. Anterior marginal ridge strong; it begins in the upper margin, digresses slightly from the anterior middle of the margin, and ultimately connects with the ventral ridge. Dorsal ridge runs clost to posterodorsal margin, and is high enough to obscure hinge line in side view. Second posterior marginal ridge very strong, consisting of two parts, one of which begins at posterior part of dorsal margin and ends in posterocentral area, where the other ridge occurs and runs toward ventral sinuous margin making a convex curve posteroventrally. This ridge has two pits at the place where the two ridges meet, and it has also a knob in the posteroventral area. Eye spot large and well developed, with a well polished surface. Marginal area, hinge structure, and muscle-scar pattern similar to other species of this genus.

Viewed from above, carapace compressed and sub-hexagonal, with second posterior marginal ridge projecting. Dorsal flat surfaces of each valves make a V-shaped trough along hinge line. Each flattened area crossed by about four transverse ridges making a reticulate pattern. Sexual dimorphism strong, female form more elongate than male.

Dimensions: Holotype (male complete carapace) length 0.60 mm., height 0.31 mm., thickness 0.25 mm.; allotype (female complete carapace) length 0.58 mm., height 0.33 mm., thickness 0.25 mm.; paratype (male complete carapace) length 0.61 mm., height 0.32 mm., thickness 0.25 mm.; (female com-

plete carapace) length 0.58 mm., height 0.32 mm., thickness 0.25 mm.

Occurrence: All type specimens were collected from Recent beach sand at Loc. 1, where they are common.

Remarks: This species has a very close resemblance to Callistocythere undulatifacialis Hanai in its size, its outline, and even in its ornamentation. However, the incomplete reticulation, and the pits on the second posterior ridge of this species are characteristics which are not developed on the carapace of Callistocythere undulatifacialis Hanai. The two species may be easily confused. However, about 30 specimens of both species at hand do not show any transitional nature.

Callistocythere undulatifacialis Hanai, n. sp.

Pl. I, Figs. 3 a-d, Pl. IV, Fig. 6.

Description: Lateral outline of carapace similar to that of Neocythere hayamensis Hanai. Surface sculptured by irregularly undulated ridges which have a tendency to run vertically in dorsal area and more or less transversely in ventral area of carapace. Subcentral tubercle prominent. Reticulations developed very poorly in anterocentral and ventrocentral areas. Ventral ridge and anterior marginal ridge similar to those of Callistocythere hayamensis Hanai. Second posterior marginal ridge begins in posterior part of dorsal margin and continues to middle of ventral margin. There is a knob-like swelling on it at the posteroventral corner. Marginal area, hinge structure, muscle-scar pattern

and eye spot similar to those of other species of this genus. Dorsal and anterior views and sexual dimorphism similar to those of Callistocythere hayamensis Hanai.

Dimensions: Holotype (male complete carapace) length 0.60 mm., height 0.32 mm., thickness 0.23 mm.; allotype (female complete carapace) length 0.57 mm., height 0.32 mm., thickness 0.25 mm.; paratype (male complete carapace) length 0.61 mm., height 0.32 mm., thickness 0.25 mm.; (female complete carapace) length 0.57 mm., height 0.32 mm., thickness 0.25 mm.

Occurrence: All type specimens were collected from Recent beach sand at Loc. 1, where they are common.

Remarks: This species is characterized by the irregularly undulating ridges, sub-central tubercles and very poorly developed reticulations on the external surface. The differences between this species and Callistocythere rugosa are given in the discussion of that species.

Callistocythere subjaponica Hanai, n. sp.

Pl. II, Figs. 4 a-e.

Description: Carapace subquadangular to subreniform, somewhat tumid, highest at anterocardinal angle. Anterior margin smooth, broadly and obliquely rounded. Dorsal margin nearly straight. Posterior cardinal angle distinct. Posterior margin truncated above, rounded below. Ventral margin sinuous near middle. Surface sculptured by low undulating ridges, which have a tendency to run vertically in dorsal area and more or less transversely in ventral area of

carapace. Anterior marginal ridge begins at upper part of anterior margin and continues to anteroventral margin. It digresses from anterior margin in its upper half. Second pos posterior marginal ridge occurs at posterior part of dorsal margin, runs nearly parallel to posterior margin and ends at posteroventral margin. In dorsal view, sides nearly straight; anterior end more pointed than posterior, and marginal ridges project slightly near each end. In end view, carapace subovate, broadest at point near mid-height; ventral outline somewhat flattened. Marginal area, hinge structure, and adductor muscle-scar pattern similar to those of other species of this genus. However, in this species, the crenulation of the anterior tooth of the right valve is more pronounced than in other Japanese species. A weak vestibult is restricted to anterior and anteroventral areas. Sexual dimorphism strong; female form larger and higher than male form, and shows more or less subquadrangular lateral outline. In dorsal view, female form appears broader than male especially in posteroventral area.

Dimensions: Holotype (male complete carapace) length 0.55 mm., height 0.30 mm., thickness 0.23 mm., allotype (female complete carapace) length 0.57 mm., height 0.32 mm., thickness 0.26 mm.; paratype (male complete carapace) length 0.50 mm., height 0.29 mm., thickness 0.23 mm.

Occurrence: All type specimens were collected from Recent beach sand at Loc. 1, where they are common.

Remarks: The surface ornamentation as well as the tumid

and somewhat cylindrical shape of the carapace of this species suggest some affinity to the Callistocythere japonica group. However, this species is shorter than C. japonica and, furthermore, the two teeth of almost equal size at the anterior termination of the intermediate bar of the left valve of this species are a characteristic of Callistocythere littoralis group hinge structure.

Callistocythere setanensis Hanai, n. sp.

Pl. IV, Figs. 3 a,b.

Description: Carapace comparatively large and thick, subquadrangular in side view, highest at anterior cardinal angle; anterior margin obliquely rounded, dorsal margin slightly arched, ventral margin nearly straight, posterior margin truncated above and rounded below. Surface ornamented by reticulations; two anterior and two posterior marginal ridges prominent. Strong ventral ridge starts in anteroventral area, runs parallel to ventral contact margin, and ends at posteroventral area, where it becomes a characteristically large, coarsely reticulate node. Marginal area, hinge structure, muscle-scar pattern similar to those of other species of this genus. In dorsal view, carapace compressed and subhexagonal, in anterior view, subovate.

Dimensions: Holotype (left valve) length 0.86 mm., height 0.46.; paratype (right valve) length 0.85 mm., height 0.46 mm.

Occurrence: All type specimens were collected from the Upper Pliocene Setana formation in the valley of Loc. 6,

where it is rare.

Remarks: This species is one of the rare cold-water Callistocythere. A coarsely reticulated node in the posteroventral area of the carapace is the most distinctive character of this species.

Callistocythere japonica Hanai, n. sp.

Pl. III, Figs. 2 a-g.

Description: Carapace elongate subreniform, somewhat tumid and subcylindrical. Anterior margin smooth, rounded obliquely. Dorsal margin slightly convex; ventral margin slightly concave, nearly parallel to dorsal. Posterior cardinal angle distinct, marked by posterior hinge tubercle. Posterior margin subtruncate above and round below. Surface sculptured by low undulating ridges which have a tendency to run obliquely forward. Small scale reticulation develops between ridges in posterocentral and ventrocentral areas. Marginal ridge occurs along posterior half of ventral margin and tends to obscure it. Second anterior marginal ridge appears near anteroventral margin, and runs along anterior margin to anterocardinal angle, being especially strong in upper half. Dorsoposterior marginal ridge starts near eye spot and is sufficiently high to obscure the straight hinge line. It reaches the lower part of the posterior margin. Second posterior marginal ridge begins in front of posterior cardinal angle and extends in an arc to middle of ventral margin. It is very strong in the posterodorsal area. In dorsal view, carapace elongate

arrowhead-shaped, pointed in front; sides nearly straight; posterior end notched. Dorsal surface of valves forms a V-shaped trough along hinge line. In anterior view, carapace appears nearly round. Flange departs from posterior extremity so as to form an apparent opening when carapace is viewed from posterior. Marginal areas and muscle-scar pattern are similar to other species of this genus. At posterocardinal angle, hingement and flange of posterior marginal area meet at posterior tooth to form almost a right angle. A moderate vestibule is restricted to anterior and anteroventral areas. Sexual dimorphism strong. Female form broader in posterocentral area and more tumid in anterior view than male form. Surface sculpture of male stronger than that of female,,especially in posteroventral area.

Dimensions: Holotype (male complete carapace) length 0.60 mm., height 0.28 mm., thickness 0.24 mm.; allotype (female complete carapace) length 0.63 mm., height 0.32 mm., thickness 0.28 mm.; paratype (male complete carapace) length 0.61 mm., height 0.30 mm., thickness 0.24 mm.; (female complete carapace) length 0.58 mm., height 0.30 mm., thickness 0.25 mm.

Occurrence: All type species were collected from Recent beach sand from Loc. 1, where they are common.

Remarks: This species is distinctive in its tumid, cylindrical, elongate form. Furthermore, the apparent opening at the posterior end is a characteristic feature of this species. A species described by Chapman (1914,

Melbourne Proc. Roy. Soc. Vict., new series, 27, p. 33, pl. 6, fig. 9) as Cythere crispata has an outline somewhat similar to that of this species. However, the ornamentation and the shape of the posterior margin of Chapman's species are quite different from those of Callistocythere japonica Hanai.

Callistocythere japonica uranipponica Hanai, n. subsp.

Pl. III, Figs. 3 a-c.

Description: Callistocythere japonica with quadrangular outline. Posterior cardinal angle distinct, posterior margin truncated and rather narrowly rounded off below. Flange runs along posterior margin. No distinct posterior notch in dorsal view, i. e., no distinct apparent opening in posterior view.

Dimensions: Holotype (complete carapace of male) length 0.64 mm., height 0.34 mm., thickness 0.27 mm.; paratype (left valve) length 0.61 mm., height 0.32 mm., thickness 0.25 mm.

Occurrence: All type specimens were collected from Recent beach sand from Loc. 5.

Remarks: Because it has the same ornamentation, this form is considered to be a subspecies of C. japonica. Callistocythere japonica s. str. appears to be restricted to the Pacific coast of Japan.

Callistocythere pumila Hanai, n. sp.

Pl. IV, Figs. 2 a-c.

Description: Carapace small, elongate subreniform, tumid, subcylindrical. Anterior margin obliquely rounded.

Dorsal margin slightly arched, nearly parallel to slightly concave ventral margin. Posterior cardinal angle distinct. Posterior margin truncated above, broadly rounded below. Surface ornamented by irregularly undulated ridges which have a tendency to run obliquely in dorsal half and parallel to ventral margin in ventral half. Reticulate pattern develops between ridges in posterior half of carapace. Two anterior marginal ridges prominent, one running from upper part of anterior margin to anteroventral margin, other starting at anterior cardinal angle, bifurcating at middle and running into anterior part of ventral margin making a convex curve anteriorly. Sulcus-like depression obliquely notched into posteroventral area. Characters of hinge structure, marginal area, and adductor muscle scar pattern similar to other species of the Callistocythere littoralis group. Front terminal tooth and socket structure of intermediate element of both valves distinct; second tooth and socket structure obscure. "Snap knob" and "pit" structure present. In dorsal view, carapace elongateovate. Dorsal surface of valves forms a V-shaped trough along hinge line.

Dimensions: Holotype (complete carapace) length 0.49 mm., height 0.25 mm., thickness 0.21 mm.; paratype (complete carapace) length 0.46 mm., height 0.24 mm., thickness 0.19 mm.

Occurrence: All type specimens were collected from Recent beach sand from Loc. 4.

Remarks: At the type locality there are a number of

specimens of this species which have greatly reduced ornamentation; this is probably the result of partial digestion by some other animals.

Genus TANELLA Kingma, 1948

1948 Tanella Kingma, pp. 87-88

Type Species: Tanella gracilis Kingma, 1948

Diagnosis: Carapace elongate and tumid; surface sculptured by reticulations and ridges. Anterior tooth of right valve replaced by elongate swelling of dorsal edge. In left valve, anterior socket lacking; anterior tooth of median bar represented by a strong anti-slip tooth.

Description: Carapace rather small, thin and oblong in outline. Surface ornamented by reticulations and ridges; anterior and posterior marginal ridges prominent. Hingement of right valve consists of elongate teeth which project slightly interiorly; an intermediate bar and a posterior crenulate tooth which is distinctly arched posterodorsally. Hingement of left valve consists of a posterior socket, an intermediate crenulate ridge with a distinct anti-slip tooth at its anterior end, and a posterior crenulate socket which opens interiorly. A containant develops just above the intermediate bar and the anti-slip tooth; the containant becomes deeper just above the anti-slip tooth to retain the elongate anterior teeth of the opposite valve. Containant opens interiorly just in front of and just behind the anti-slip tooth. The anti-slip tooth fits between the two or more very elongate anterior teeth of the right valve. Dup-

licature moderate, widest at anteroventral area where sometimes a vestibule is present. Radial pore canals typically polyfurcate. Ventral sinuous margin of right valve has a "snap knob" and the left valve has a "snap knob" and the left valve has a "snap pit" as previously described for Callistocythere. Adductor muscle-scar pattern consists of four scars in one vertical row and two in front of them. Sexual dimorphism very strong, female forms having inflated carapace.

Tanella miurensis Hanai, n. sp.

Pl. III, Figs. 1 a-e.

Description: Carapace thin, oblong and tumid, highest slightly posterior to anterior cardinal angle. Anterior margin obliquely rounded. Dorsal margin nearly straight, inclined toward posterior. Ventral margin straight, slightly sinuous at anterior end. Posterior margin truncated above, narrowly rounded below. Surface sculptured by reticulations, each reticulation consisting of about two to four deep pits. Pits coarse in anterocentral area. Anterior marginal ridge strong; beginning at anterocardinal angle and ending in anteroventral area. Posterior marginal ridge strong, beginning in posterior part of dorsal margin and extending in an arc to posteroventral area, becoming straight and running parallel to ventral margin to ventral sinuous area. Shallow, vertical, median sulcus in dorsocentral area just above muscle-scar area. Hinge structure typical of genus; anterior half of hinge line arched, pos-

terior half straight. Marginal area and adductor muscle-scar pattern same as for genus. Viewed from above, carapace ovate with anterior and posterior marginal ridges projecting. Dorsal flat area of valves makes a V-shaped trough along posterior half of hinge margin. In end view, carapace subovate. Sexual dimorphism very strong. In side view, posterior cardinal angle of female form less than 90°, that of male more than 90°. Viewed from above, female form much more inflated than male; thickest part of carapace near center in male form, but well to posterior in female form.

Dimensions: Holotype (male complete carapace) length 0.56 mm., height 0.28 mm., thickness 0.22 mm.; allotype (female complete carapace) length 0.60 mm., height 0.32 mm., thickness 0.28 mm.; paratype (male complete carapace) length 0.56 mm., height 0.28 mm., thickness 0.23 mm.

Occurrence: All type species were collected from Recent beach sand from Loc. 1, where they are rare.

Comparison: This species differs from Tanella gracilis Kingma in 1) the development of a vestibule, 2) a shorter outline, 3) the crenulation of the intermediate bar of the right valve, and 4) two elongate anterior teeth of the right valve which are represented by an elongate tooth in Tanella gracilis.

Genus MICROCALLISTOCYTHERE Hanai, n. gen

Type Species: Microcallistocythere minor Hanai, n. sp.

Diagnosis: Thick-shelled Leptocytherinae with com-

pressed anterior margin and characteristic posteroventral projection. Hinge merodont with containant. Anterior and posterior tooth-and-socket structure distinct. Median element not differentiated into two-fold elements. Line of concrescence almost coincides with inner margin. Color usually yellow.

Description: Carapace thick and small, subquadrangular and elongate in lateral outline. Carapace compressed along anterior margin, having characteristic projection at posteroventral area. Surface ornamented by irregularly undulated ridges. Marginal area moderately broad in anterior and posteroventral areas. Radial pore canals polyfurcated. Hingement of right valve consists of an anterior crenulated tooth, an intermediate smooth to faintly crenulate bar and a posterior distinct and crenulate tooth. Hingement of left valve consists of anterior socket, intermediate faintly crenulate bar, and posterior socket. Both sockets connected by a containant just above intermediate bar and below flange. Sockets open interiorly. Teeth of anti-slip nature develop in front of anterior socket and behind posterior socket. In right valve, faintly crenulated shelves develop just below anterior and posterior terminal parts of intermediate bar so as to receive high and strong anterior and posterior parts of median bar of left valve. Adductor muscle scars a little below center; at least four scars in a vertical row. "Snap knob-and-pit" structure obscure.

Relationships: This genus is closely related to Callistocythere. It differs especially in hinge structures. The species described by Pokorny (1952) as Leptocythere lacunosa (Reuss) has a similar hingement. It is at present difficult to conclude that merodont type hingement is phylogenetically older than the other type of hingement in Leptocytherinae, in spite of the fact that the young molt of the Leptocyhterinae has a merodont "Archicythereis" type hingement.

Microcallistocythere minor Hanai, n. sp.

Pl. IV, Figs. 1 a-e.

Description: Carapace thick, small elongate and subquadrangular in lateral outline. Anterior margin broadly and obliquely rounded, dorsal margin straight and long, inclined slightly toward posterior, ventral outline straight, nearly parallel to dorsal margin. Posterior margin truncated obliquely in upper half and lower half so as to make blunt angulation at mid-height. Carapace compressed along anterior margin. Surface ornamented with irregularly undulated ridges. Ridges prominent in ventral and posteroventral areas; a prominent ridge projects in broad V-shaped surrounding a very deep depression in the posteroventral area. In dorsal view, sides nearly parallel. Carapace slightly constricted in central adductor-muscle area; however, place of muscle-scar attachment slightly protruded. Hinge structure, adductor muscle-scar pattern and marginal area same as for genus. In interior view, ventral contact margin sinuous at middle.

Dimensions: Holotype (a complete carapace) length 0.42 mm., height 0.21 mm., thickness 0.16 mm.; paratype (a complete carapace) length 0.41 mm., height 0.19 mm., thickness 0.15 mm.; (a complete carapace) length 0.39 mm., height 0.18 mm., thickness 0.14 mm.

Occurrence: All type specimens were collected from Recent beach sand at Loc. 3, where they are common.

Subfamily "Toulminiinae" Hanai, n. subfam.

Type Genus: "Toulminia" Munsey, 1953

Diagnosis: Carapace small and thick, subquadrangular in lateral outline. Surface coarsely punctate and/or ornamented with undulated ridges, and having marginal ridges tending to circumscribe periphery of carapace. Marginal area broad. Vestibule develops along anteroventral margin. Radial pore canals simple, straight, and few. Hinge modified merodont. Left valve hingement consists of anterior and posterior sockets which open valve interiorly and a median crenulate bar between. Anterior and posterior terminations of median bar swell into knob-like projections, one at each end. Right valve with two terminal teeth and a median groove between. Anterior and posterior terminations of median groove widened and deepened to form sockets, one at each end.

Description: Shape and ornamentation variable; however, ridges tend to circumscribe margin of carapace, being especially strong along anterior margin and obscure along posteroventral margin. In thick-shelled species the marginal ridge becomes obscure; but, the marginal area becomes very thick owing perhaps to the fusion of the marginal ridge and the carapace. Left valve tends to overlap right at anterodorsal corner. Normal pore canals large, few, and scattered. Adductor muscle-scar pattern consists of four vertical scars and at least one scar anterior.

Remarks: The subfamily "Toulminiinae" which has an

outline similar to that of the subfamily Leptocytherinae. The main difference between the two subfamilies is the presence in the Leptocytherinae of polyfurcated radial pore canals and of a containant structure in the hingement. Some genera of the subfamily Cytherurinae, i. e., genus Tetracytherura Ruggieri, 1952, include the species which have a median bar in the left valve terminated at each end by small tooth-like projections. However, in the other characters, including the details of hinge structure, the Cytherurinae do not show close relationship to the "Toulminiinae" the anterior and posterior tooth-like projections of the median bar in the left valve are not simple as in the Cytherurinae, but consist of two parts, each with upper and lower elements.

This subfamily includes the following genera:

"Toulminia" Munsey, 1953.

Neocythere Hanai, n. gen.

Arcacythere Hornibrook, 1953

According to Hornibrook (1953), the hingement of Arcacythere does not show any differentiation of the median element; however, its thick-box-shaped carapace with circumscribed ridge and characteristic overlapping of left valve over right at the anterior cardinal angle suggests close relationship of Arcacythere to Neocythere.

Historical review and age: This group of ostracods has not yet been studied in detail because of the small size of the carapace. Two species, Arcacythere chapmani

Hornibrook from the Lillburnian (Middle Miocene) of New Zealand and "Toulminia" hyalokystis (Munsey) from the Coal Bluff member of the Naheola formation (Paleocene) of the Gulf Coastal Plain of the United States are the only ones which have so far been described properly and considered to belong to the Subfamily "Toulminiinae". According to Hornibrook (1952) Arcacythere ranges from Piripauan (Upper Cretaceous to Waiauan (Middle Miocene) and occurs only in New Zealand. "Toulminia" is known from the Paleocene of the Gulf Coastal Plain of the United States and from Pliocene to Recent of the Japanese coast. The genus Neocythere is so far known only from Pliocene deposits in Japan.

Genus "TOULMINIA" Munsey, 1953

1953 Toulminia Munsey, pp. 6-7.

Type Species: Toulminia hyalokystis Munsey, 1953.

Diagnosis: Small "Toulminiinae" having compressed and subquadrangular carapace, with nearly straight posterior outline. Surface heavily ornamented. Marginal ridge nearly circumscribes periphery of carapace. In hingement of left valve, lower non-crenulate elements of anterior and posterior teeth are smaller than upper elements. Both upper and lower elements are usually fused together so as to make one knob-like projection. Radial pore canals straight and few.

Description: Carapace small, moderately thick, compressed and subquadrangular in lateral outline. Anterior margin broadly and obliquely rounded and sometimes carrying

short spine-like projections or a thin marginal lip. Dorsal and ventral margins nearly straight. Posterior margin short and straight making a right angle with ventral margin and bearing one to three blunt spines. Surface heavily ornamented with undulated ridges. A prominent ridge circumscribes periphery of carapace. Hinge of right valve consists of an anterior and posterior knob-like non-crenulate teeth and median finely crenulate groove between. Anterior and posterior terminations of median groove enlarged and deepened so as to form small sockets. Hinge of left valve consists of anterior and posterior sockets and median crenulate bar between. Anterior and posterior sockets open into the valve interior. Just posterior to anterior socket and just anterior to posterior socket terminations of median bar swell into low tooth-like projections. Teeth in left valve consist of upper elements which are swollen portions of the median bar. Below these are attached supplemental teeth which appear to brace the bar-teeth. In the genus "Toulminia" the upper element is about equal to or larger than the lower element. Sometimes the upper element develops extremely well and lower element becomes an attachment of the upper element. Marginal area broad anteriorly and posteroventrally. Vestibule well-developed, and deep anteroventrally, and poorly developed posteroventrally. Radial pore canals simple, short, and few. Normal pore canals few and scattered over carapace. Adductor muscle-scar pattern consists of posterior vertical row of four

scars and at least one anterior scar. Sexual dimorphism observable. Convergence of ventral and dorsal margins less strong in female forms.

Remarks: The change of the generic name will be made by Munsey. This is due to the preoccupation by the sponge genus Toulminia Zittel 1878.

"Toulminia" japonica Hanai, n. sp.

Pl. V, Figs. 1 a-e.

Description: Carapace thick and small, subrhomboidal in lateral outline, highest at anterior cardinal angle. Anterior margin obliquely rounded, with about three crenulations of marginal rim in its lower half. Dorsal margin slightly convex sloping moderately posteriorly, ventral margin nearly straight. Posterior outline also nearly straight, making almost a right angle with ventral margin, and having prominent spines, one at mid-height and another at posteroventral corner. Surface ornamented with undulated ridges. A prominent ridge circumscribes entire margin and is especially high along anterior and posterior margin where it deviates a little from the margin, owing to the strong development of the marginal rim. Inner bordering depression develops along anterior and posteroventral portion of marginal ridge; depression especially strong in posteroventral area. Undulated ridges inside of marginal ridge disposed more or less vertically. A prominent ridge starts at anteroventral portion of marginal ridge, runs posteriorly, then changes direction upward in posteroven-

Posteroventral contact margin narrowly rounded in side view. Character of hinge, marginal area and adductor muscle scars same as those of genus, but anterior and posterior teeth of left valve more distinct and more rounded than in type species. Lower non-crenulate element of anterior and posterior teeth moderately developed. Sexual dimorphism strong; in female form dorsal and ventral outlines not so much convergent as in male form. Two strong posterior spine-like projections in male and three weak projections in female. Moreover, female form has a characteristic posterodorsal projection.

Dimension: Holotype (male complete carapace) length 0.40nmm., height 0.21 mm., thickness 0.18 mm.; allotype (female complete carapace) length 0.44 mm., height 0.22 mm., thickness 0.18 mm.; paratype (male complete carapace) length 0.39 mm., height 0.21 mm., thickness 0.17 mm.; (male complete carapace) length 0.43 mm., height 0.22 mm., thickness 0.18 mm.

Occurrence: All type specimens were collected from Recent beach sand at Loc. 1, where they are common.

Remarks: "Toulminia" hyalokystis Munsey from Paleocene of the Gulf Coastal Plain of the United States is the only species of this genus which has been previously described. The Japanese Recent species shows striking resemblance to the American Paleocene species but in detail it is quite different, e. g. the surface ornamentation is not the same as that of the American species.

Difference in hingement as mentioned above might suggest an evolutionary trend in the hingement of this group of Ostracoda.

"Toulminia" hokkaidoana Hanai, n. sp.

Pl. V, Figs. 2 a-b.

Description: Lateral outline similar to "Toulminia" japonica, but larger and showing characteristic thin lip along anterior margin. Surface finely punctate except on blunt ridges. Prominent marginal ridge circumscribes entire periphery of carapace, being especially strong along anterior margin. Inner bordering depression deep along anterior margin and in posteroventral area. Two tubercles prominent in dorsocentral area. Very prominent ridge starts at posterior tubercle, runs posteriorly a short distance, turns downward in posterodorsal area, and terminates in middle of posterior area. Other ridges less prominent. In side view, posteroventral contact margin narrowly rounded, ventral contact margin sinuous at middle. Hinge structure, characters of marginal area, and adductor muscle-scar pattern typical of genus.

Dimensions: Holotype (female complete carapace) length 0.49 mm., height 0.28 mm., thickness 0.23 mm.

Occurrence: The type specimen was obtained from the Setana formation (Upper Pliocene) in the valley of Loc. 6.

Remarks: This species is closely related to "Toulminia" japonica, but the carapace of this species is larger and less sculptured than that of "Toulminia" japonica. The

lower elements of the anterior and posterior teeth of the left valve of this species is not so well developed as those in "T." japonica.

Genus NEOCYTHERE Hanai, n. gen.

Type Species: Neocythere quadrangulata Hanai, n. sp.

Diagnosis: Very thick-shelled "Toulminiinae" with oblong box-shaped shell. Marginal area of carapace especially thick because of ridges which are extremely blunt and bold, having a tendency to circumscribe periphery of shell. Hingement similar to that of other "Toulminiinae", but in left valve, lower non-crenulate elements of anterior and posterior teeth are larger than upper elements; both elements are well separated from each other. Along anteroventral margin, radial pore canals tend to be grouped in pairs, one of which opens nearer the contact margin than the other.

Description: Nature of carapace outline and surface ornamentation are same as described in the diagnosis. Along anterior margin a thin lip-like projection usually develops. Hingement is similar to "Toulminia", but differs in details mentioned in diagnosis. Anterior tooth and socket structure well developed in comparison with posterior. Marginal area broad anteriorly, vestibule well-developed along anterior obliquely rounded margin and poorly along posteroventral margin. Radial pore canals few, and tending to be grouped in pairs, one of which opens nearer the contact margin than the other, along vestibule

area. Normal pore canals few and scattered. Adductor muscle-scar pattern consists of a posterior vertical row of four scars and one anterior scar.

Remarks: The box-shaped carapace shows close relationship to Arcacythere described by Hornibrook (1952) from the Cretaceous to Miocene of New Zealand, but the hinge structure is quite different. Moreover, the marginal ridge of Neocythere is not so continuous as that of Arcacythere especially in the posteroventral area. "Toulminia" shows similar type of hinge structure, but in detail, the lower non-crenulate element of the anterior and posterior teeth in the left valve are larger than the upper element.

Neocythere quadrangulata Hanai, n. sp.

Pl. V, Figs. 3 a-b. Pl. IV, Figs. 7.

Description: Carapace small and extremely thick, box-shaped. Anterior margin broadly and obliquely rounded with thin lip-like projection. Dorsal margin slightly arched, inclined toward posterior. Ventral margin nearly straight. Posterior margin truncated above and rounded below. Surface ornamented by scattered punctations, which are the openings of normal pore canals, and blunt thick ridges, which more or less circumscribe periphery of carapace, except anteroventral and posteroventral areas. One ridge starts in anteroventral area, runs posteriorly obscuring middle part of ventral contact margin, and terminates in posteroventral area. Another ridge

starts at mid-height of anterior area, runs upward along anterior margin, then circumscribes periphery of dorsal margin, and terminates in mid-height of posterior area, where ridge becomes extremely strong. A small ridge appears along rounded posteroventral margin. Ridges run along and close to anterior and posterior peripheries of carapace but do not quite reach peripheries. Open area inside of ridges also ornamented with complex of blunt and thick ridges and swellings. In interior view, hingement straight and ventral contact margin sinuous at middle. Hinge structure, character of marginal area, and adductor muscle-scar pattern same as for genus. In dorsal view, hinge line marked by shallow trough and posterior tooth of left valve more protruded than anterior tooth. Dorsal side of both valves nearly straight in outline and parallel each other.

Dimensions: Holotype (complete carapace) length 0.54 mm., height 0.30 mm., thickness 0.27 mm.; paratype (complete carapace) length 0.52 mm., height 0.29 mm., thickness 0.27 mm.

Occurrence: Type specimens were obtained from the Setana formation (Upper Pliocene) from the valley of Loc. 6, where they are rare.

Remarks: Outline of this species different from "Toulminia", in detail but circumscribing ridges and hinge structure suggest that this species retains some relationship to "Toulminia".

Neocythere pseudoamphidonta Hanai, n. sp.

Pl. V, Figs. 4 a-c.

Description: Carapace small and extremely thick-shelled, subovate in lateral outline, highest at anterior cardinal angle. Anterior margin obliquely rounded, dorsal margin sinuous in anterior half and arched in posterior half, owing to strong projection of dorsoposterior ridge. Ventral margin nearly straight. Posterior cardinal angle distinct. Posterior margin truncated above and rounded below. Surface ornamented with scattered punctations which are outer surface openings of normal pore canals. An extremely blunt and thick ridge starts at anterior cardinal angle, runs down along anterior margin, and splits into about three fine parallel ridges. One of the fine ridges. One of the fine ridges continues along ventral marginiinto posterior part of carapace. Anterior ridge does not quite reach anterior margin in lateral view in its upper half and projects over anterior margin in its lower half. Another extremely strong, blunt ridge starts posterior to middle of dorsal margin and terminates in mid-height of posterior area. A ventral thick, blunt, and more or less wing-like ridge swells in posteroventral area. Hinge structure, character of marginal area, and adductor muscle-scar pattern essentially the same as type species of genus. However, lower elements of anterior and posterior teeth of left valve well-developed so as to form large, round, knob-like projections, especially in anterior tooth. In anterior view, carapace appears to be

trapezoidal owing to flat ventral area and thick, blunt, wing-like projections in posteroventral area. In the dorsal view, wing-like ventral projection prominent, hinge line straight and marked by a shallow trough. At anterior cardinal angle left valve overlaps right.

Dimensions: Holotype (aaleft valve) length 0.60 mm., height 0.35 mm.; paratype (a complete carapace) length 0.64 mm., height 0.37 mm., thickness 0.35 mm.

Occurrence: All type specimens were obtained from the Setana formation (Upper Pliocene) from the valley of Loc. 6, where they are rare.

Remarks: The lapping of the left valve over the right at the anterior cardinal angle suggests relation of this species to Arcacythere. From Neocythere quadrangulata this species differs in its large size, surface ornamentation, and the well developed anterior knob-like tooth of the left valve.

Subfamily Cytherurinae G. W. Muller, 1894

1894 Cytherurinae G. W. Muller, p. 286.

1925 _____ G. O. Sars, p. 199.

1925 Loxoconchinae G. O. Sars, p. 217. (part.)

1938 Cytherurinae Klie, p. 187.

1941 _____ Elofson, pp. 304-305.

1955 _____ Swain, p. 626.

Type Genus: Cytherura G. O. Sars, 1865.

Diagnosis: Carapace small, usually with wing-like process and posterior caudal extension, usually sculptured. Right valve larger than left, especially along dorsal margin. Hinge merodont. Right valve with terminal knob-like teeth, one or rarely more than two at each end of the long blade-like ridge of the inner lamella, but usually small and indistinct in Cytherura group. In Cytheropteron group, teeth of right valve strong and crenulate or consisting of a series of knob-like teeth; blade-like ridge of inner lame lamella usually not well developed.

Description: Shape variable. Wing-like lateral expansion usually characteristic of subfamily, but obscure in some species of Cytherura group. Posterior caudal process usually prominent. Hinge merodont, and classifiable on basis of crenulations into two types mentioned in diagnosis; the first is here called Cytherura type, and the second is called Cytheropteron type. Hingement is also classifiable on the basis of hinge and flange arrangement: 1) flange strongly developed and overhanging the actual hinge element

of right valve, but not reaching the terminal teeth so as to form a furrow between the terminal teeth and the overhanging flange. This type hingement is usually arched or if straight it is short. It is here called arched or short type. 2) flange not greatly overhanging the actual hingement and reaching the terminal teeth. This type of hingement is usually straight and long. The crenulate groove between the terminal teeth is well developed. This second type is here called long straight type. The marginal area is extremely well developed in some of the Cytherura group in which the inner margin coincides with the line of concrescence and curves forward in the back half of the carapace. The radial pore canals tend to be grouped in this type of marginal area. In the Cytheropteron group usually the development of the marginal area is moderate and there is a vestibule. The radial pore canals are usually simple. However, in both cases the number of radial pore canals is small. Adductor muscle scars are all nearly the same, usually arranged in a posterior vertical row of four scars and one or two anterior scars. Eye spots are rather distinct in the Cytherura group, but are not distinct in the Cytheropteron group, except Paracytheridea and its allies.

Remarks: Until G. O. Sars (1865) established the genera Cytherura and Cytheropteron as genera of the family Cytheridae, cytherurine Ostracoda had been included in the genus Cythere. In 1894, G. W. Muller proposed the Subfamily Cytherurinae and included three genera, Cytherura,

Cytheropteron, and Eucytherura. In 1925 G. O. Sars restricted the Subfamily Cytherurinae to "the Ostracoda chiefly referable to the genus Cytherura". He included the genus Cytheropteron in his Subfamily Loxoconchinae. After this, confusion of the classificatory position of the genus Cytheropteron and its allies arose. Some authors followed G. W. Muller (e. g. Klie, 1938) and some followed G. O. Sars opinion (e. g. Doeglas, 1931, Blake, 1933). In 1941, Elofson tabulated the anatomical characters of Cytherura, Cytheropteron, and Loxoconcha and concluded that "Eine sorgfaltige Untersuchung ergibt bald, dass G. W. Muller mit seiner Ansicht ganz recht haben muss. Die Eigenschaften, welche die beiden Gattungen Cytherura and Cytheropteron gemeinsam haben, sind namlich sowohl quantitativ als qualitativ den Cytheropteron und Loxoconcha gemeinsamen weit uberlegen". In spite of Elofson's clear explanation in 1941, the confusion of the classificatory position of the genus Cytheropteron has continued (e. g., Van den Bold, 1946, Bowen, 1953, Munsey, 1953, Apostolescu, 1955). So far as the hinge structure is concerned, Loxoconchinae are distinctly different from Cytherurinae. Although this Subfamily is of uncertain status, the following genera and subgenera have been assigned to it or considered to be closely related to it.

1. Cytherura group

Hinge short or arched and of Cytherura type.

Cytherura G. O. Sars, 1865 (1866) pp. 69-70, Type Species: Cythere gibba O. F. Muller, 1785, p. 66, designated by

Brady, 1868, p. 439.

Hemicytherura Elofson, 1941, p. 314, Type Species: Cy Cythere cellulosa Norman, 1865, p. 22, by original designation. The genus was proposed by Elofson (1941) as a subgenus of Cytheropteron. This group of Ostracoda corresponds also to the Cytheropteron videns group which was originally included in Cythere and later in Cytherura, and has been separated from Cytherura, and included in Cytheropteron by G. W. Muller in 1894. Recently Ruggieri, 1952, considered Hemicytherura a subgenus of Cytherura instead of a subgenus of Cytheropteron, because of: 1) the eyes which are shown on the carapace by the clear eye spots, 2) the Cytherura type hinge line, and 3) the coincidence of the inner margin with the line of concrescence. In the same year, 1952, Hornibrook raised this subgenus to generic rank.

Tetracytherura Ruggieri, 1952, p. 28, Type Species: Cytheridea angulosa Seguenza, p. 363.

Microcytherura G. W. Muller, 1894, p. 383, Type Species: Microcytherura nigrescens G. W. Muller, 1894. As to the systematic position of this genus Klie (1938) stated as follows: "G. W. Muller hat 1894 fur eine Art des Golfs von Neapel, die in der Farbe und in der Schalenform an die Gattung Cytherura erinnert, das Genus Microcytherura begrundet, das bis heute nur durch die dortige Art nigrescens vertreten war. Der Gattungsname konnte zu dem Missverstandnis Veranlassung geben, dass Microcytherura mit Cytherura nahe verwandt sei, etwa wie Microcestoleberis mit Xestoleberis.

Das ist jedoch keineswegs der Fall. Microcytherura gehort vielmehr zweifellos zur Unterfamilie Cytherinae, der gegenuber die Cytherurinae eine selbstandige Unterfamilie bilden."

Howeina Hanai, n. gen., Type Species: Howeina campto-cytheroidea Hanai, n. sp.

2. Cytheropteron group

a. Hinge arched and of Cytheropteron type.

Cytheropteron G. O. Sars, 1865,(1866), pp. 79-80, Type Species: Cytheropteron convexum (Baird) by G. O. Sars on mistaken identification, = Cythere latissima Norman, 1965, by Brady, 1868, p. 448, by Brady and Norman, 1889, p. 207, and by G. O. Sars, 1926, p. 223.

Aversovalva Hornibrook, 1952, p. 57, Type Species: Cytheropteron (Aversovalva) aureum Hornibrook, 1952, by original designation. This subgenus of Cytheropteron has the left valve larger than the right owing to the strong development of the groove above the median bar of the left valve for accomodating the dorsal edge of the right valve. This genus is the only one in the Cytherurinae which has the right valve larger than the left.

Kangarina Coryell and Fields, 1937, p. 12, Type Species: Kangarina quellita Coryell and Fields, 1937, by original designation. This genus from the Miocene of Panama was originally included in the Subfamily Loxoconchinae. This assignment was followed by Van den Bold (1946). However Ruggieri (1952) considered it a subgenus of Cytheropteron because of the absence of eyes and its habitat.

Kobayashiella Hanai, n. gen., Type Species: Kobayashiella hyalinosa Hanai, n. sp.

b. Hinge straight and of Cytheropteron type.

Paracytheridea G. W. Muller, 1894, p. 340, Type Species: Cytheropteron bovettensis Seguenza, 1880. This genus has been placed by Van den Bold, 1946, in the Cytherideinae.

Paracytheridea (Paracytheropteron) Ruggieri, 1952, p. 78-79, Type Species: Cytheropteron calcaratum Seguenza, 1880. This genus has a carapace whose shape is intermediate between Paracytheridea and Cytherura, but has a Cytheropteron-type hinge and is considered intermediate between Paracytheridea and Cytheropteron by Ruggieri (1952). It is noteworthy that he compared his Paracytheropteron with Lophocythere of the Progonocytherinae.

Pseudocytherura Dubowsky, 1939, pp. 12-16, Type Species: Pseudocytherura pontica Dubowsky, 1939. As to the systematic position of this genus, Dubowsky stated as follows: "Die allgemeine Schalenform, die Strukture des Innerandes, die Eigenschaften der Maxilla und der Furca stella diese neue Gattung den von G. W. Muller in Subfam. Cytherurinae vereinigten Gattung nahe. Die structur der I Antenne aber, die 4-gliedrigkeit der II-ten, wie die Abwesenheit der II-ten ventralen (hintern) Borste am Basalglied des I Bein-paares unterscheidet scharf Pseudocytherura von dieser Gruppe, stellt sie zur Gattung Paracytheridea nahe und verbindet durch Ubergange Cytherurinae (im Sinne von G. W. Muller) mit den ubrigen Cytheridae".

3. Eocytheropteron group

Although many species of this group had no trace of wing-like lateral expansions, they have a close resemblance in outline to the Cytheropteron group, especially in the shape of the caudal process; however, the hinge structure of this group is quite dissimilar to that of the Cytheropteron group in the following characters:

1) there is development of a flange above the hinge element of the right valve, and the overhanging flange above the hinge element of the left valve causes the lapping of the left valve over the right along the dorsal margin.

2) the crenulations are comb-like instead of the pit-and-knob type. Differentiation of the terminal teeth from the median element is somewhat indistinct, because the intervals between crenulations are almost constant. However, the crenulations in the left valve are deepened and are overhung greatly by the flange along the anterior and posterior portions of the hingement, where the individual notch of the crenulations is more elongate vertically than those of the median portion. The right valve hingement is complementary. The hinge structure described above is quite different from those of other Cytherurinae. Perhaps the following genera will form a new group of Ostracoda which has subfamily rank.

Eocytheropteron Alexander, 1933, p. 195. Type Species: Cytheropteron bilobatum Alexander, 1929, by original designation. This genus was originally described by Alexander, 1933, as a subgenus of Cytheropteron. This assignment has

been followed by most workers. Independently from Alexander's work, Broussard (1932) studied this genus and recognized it as a genus of uncertain systematic position.

Budaia Mehes, 1941, p. 67, Type Species: Budaia prima Mehes, 1941, by original designation.

4. Uncertain genera

Eucytherura G. W. Muller, 1894, p. 305, Type Species: Cythere complexa Brady, 1867, p. 210, designated by Alexander, 1936, p. 629. This genus has been included in the subfamily Cytherurinae since the original description, and has been reviewed thoroughly by Weingeist (1949).

Orthonotacythere Alexander, 1933, pp. 199-200, Type Species: Cytheridea hannai Israelsky, 1929, p. 12, by original designation. This genus was originally compared with Monoceratina and was believed by Alexander to have been derived from Monoceratina. Martin (1940) classified this genus in the Subfamily Cytherurinae, and later Van den Bold (1946) placed it in the Subfamily Loxoconchinae, in which he also included Cytheropteron and its allies.

Looneyella Peck, 1951, pp. 575-576. Type Species: Cythere monticula Jones, by original designation. Peck (1951) compared this genus to the Upper Jurassic genus Hutsonia Swain; he stated that this genus may have develop- from Hutsonia.

Genus CYTHERURA G. O. Sars, 1865 (1866)

Cythere auct. (part.)

1865 (1866) Cytherura G. O. Sars, pp. 69-70.

1866 _____ Brady, Int. Obs., p. 124.

1868 _____ Brady, Mon., p. 439. (Designation of Genotype).

1874 _____ Brady, Crosskey and Robertson, pp. 191-192.

1878 _____ Brady, Antwerp., p. 401.

1880 _____ Brady, p. 130.

1888 _____ Dahl, p. 626.

1889 _____ Brady and Norman, p. 190.

1894 _____ Lienenklaus, p. 238.

1894 _____ G. W. Muller, p. 287.

1900 _____ Namias, p. 109.

1900 _____ Lienenklaus, p. 539.

1905 _____ Lienenklaus, p. 54.

1912 _____ G. W. Muller, p. 263.

1925 _____ G. O. Sars, p. 199.

1928 _____ Naviani, p. 32.

1936 _____ Alexander, p. 690.

1936 _____ Van Veen, p. 21.

1938 _____ Klie, Tierwelt, pp. 187-188.

1941 _____ Elofson.

1944 _____ Edwards, p. 525.

1946 _____ Van den Bold, p. 34.

1946 _____ Stephenson, p. 316.

1948 _____ Kingma, p. 33.

1952 _____ Hornibrook, p. 50.

1955 _____ Swain, p. 626.

Type Species: Cythere gibba O. F. Muller, 1785.

Diagnosis: Cytherurinae having small and subquadrate carapace with caudal process. Hinge merodont of Cytherura type, arched or straight but short; anterior and posterior teeth knob-like and single or rarely paired at each end of hinge at the termination of the blade-like ridge of the inner lamella of right valve. Marginal area well-developed and irregular. Line of concrescence coincides with inner margin. Radial pore canals tend to be grouped. Eye usually distinct.

Description: Shape and ornamentation variable, usually with wing-like process and posterior caudal extension. Right valve larger than left, especially along dorsal margin. Line of concrescence coincides with inner margin. Calcified portion of inner lamella extremely well-developed in some species, in which inner margin is in some cases parallel to outer margin, in others irregular and makes modified S-shape in posterior region. Radial pore canals not numerous, tending to be grouped. Usually three radial pore canals in posterior caudal area. Right valve hingement has one, or rarely two, terminal teeth which are knob-like but not very distinct at each end of blade-like outer edge of inner lamella. Flange developed strongly and projecting over actual hinge element, but not quite reaching terminal teeth. Hinge of left valve has a median bar and terminal sockets. The bar usually crenulate and thickened so as to form knob-like projections in its terminal parts; bar fits into groove or

trace of groove just under overhanging flange and between terminal teeth of right valve. Groove usually crenulate and sometimes having socket-like pits in terminal parts. Flange developed over hinge element immediately above anterior and posterior terminal sockets of left valve; the flange fits furrow between terminal teeth and overhanging flange of right valve. Sometimes furrow continues a long distance between posterior blade-like inner lamella and overhanging flange. Median bar usually slightly projecting over flange in dorsal view. Adductor muscle-scar pattern consists of four posterior vertical scars and one anterior. Eye usually distinct.

Remarks: G. W. Muller (1894) divided the genus Cytherura into two groups: 1) shell with wing-like process, 2) shell without wing-like process. Furthermore, he divided the first group into two subgroups: 1a) shell without any indication of longitudinal ridges over the wings, 1b) shell with distinct longitudinal ridges over the wings. Among Japanese species, Cytherura miurensis Hanai, n. sp., and C. tetragona Hanai, n. sp., might belong to the second group of G. W. Muller. The other Japanese Cytherura do not belong to any of the groups or subgroups of G. W. Muller, and may form a new group of Cytherura which is characterized by thick undulated ridges, perhaps exemplified by Cytherura undata, G. O. Sars. This group of Cytherura usually has a quadrate outline and rather thick shell.

Cytherura tetragona Hanai, n. sp.

Pl. VI, Figs. 5 a-d.

Description: Carapace sub-tetragonal in lateral outline, highest at anterior cardinal angle. Anterior margin obliquely rounded, dorsal and ventral margins straight, nearly parallel to each other, posterior caudal process inconspicuous, blunt, and located at mid-height, pointed posteriorly. Surface ornamented by dense, fine punctations and fine ridges. Punctations somewhat coarse in central area. Ridges prominent in ventral area where several long and fine ridges run parallel to ventral margin. In anterior area, a fine ridge runs along anterior margin and four to five ridges run from adductor muscle scar area to anterior margin more or less radially. Posterocentral surface rather inflated and lacking fine ridges. Eye spot distinct. Hinge straight, arrangement typical of genus. Anterior tooth of the right valve represented by a knob-like projection. Posterior tooth not well defined from the flange-like ridge along posterior margin. Median groove socketed in its anterior and posterior parts. In middle part, groove becomes obscure. Hingement of the left valve complementary. Marginal area extremely broad, a character typical of this genus. Adductor muscle scars typical of genus with an additional three scars above and two scars below. Anterior view subtriangular with more or less flat ventral surface. Dorsal view oblong with more or less sharp anterior and posterior points.

Dimensions: Holotype (complete carapace) length 0.44

mm., height 0.22 mm., thickness 0.18 mm.; paratype (complete carapace) length 0.36 mm., height 0.18 mm., thickness 0.15 mm.

Occurrence: The holotype was obtained from Recent beach sand from Loc. 1. The paratype was obtained from a beach sand, Loc. 5, where the species is rare.

Remarks: Inside views of this species show clearly the fact that the anterior and posterior teeth of the right valve are modifications of the edge of the inner lamella and the flange over the hingement is a modification of the outer lamella. This species has some resemblance to Cytherura simplex Brady and Norman.

Cytherura miurensis Hanai, n. sp.

Pl. VI, Figs. 4 a-d.

Description: Carapace very thin and subtransparent, oblong in lateral outline. Anterior margin broadly rounded, dorsal margin arched and highest at middle, ventral margin nearly straight, sinuous in anterior part; posterior caudal process prominent, more or less upturned and acute. Valves inflated and rather tumid with a very shallow sulcus-like depression in central part. Ventrolateral area of valves hang down slightly so as to make ventral area flat. Surface ornamented by fine ridges running more or less longitudinally. Vertical ridges develop partially between longitudinal ridges so as to form a "cobweb" pattern. Longitudinal ridges prominent in ventral area. Between ridges surface minutely punctate. Hinge arrangement typical of genus.

Anterior tooth of right valve represented by a series of about three tiny, rounded teeth at termination of ridged selvage. Median element smooth. Posterior tooth represented by a series of one or two tiny, rounded projecting teeth at termination of long ridged selvage. Hingement of left valve is complementary. Adductor muscle scars at central area where external medial sulcus swells up internally. Details of scars not observable. Marginal area developed anteriorly and posteriorly; line of concrescence coincides with inner margin; at anteroventral area inner margin of the inner lamella has a small but characteristic situation. Posterior marginal area broad, its inner margin S-shaped starting at posterior end of the hingement, making a convex curve toward center in its upper two-thirds and strongly concave in lower one-third, and reaching near the middle of ventral margin of carapace. Radial pore canals have a tendency to be grouped, especially along anteroventral margin, and prominent in posteroventral and posterodorsal areas. In some specimens which have a rather narrow anterior margin and less inflated posterocentral area, posterior marginal area becomes obscure. In dorsal view, carapace oblong, oval, thickest posteriorly; posterior end pointed. In anterior view, carapace ovate.

Dimensions: Holotype (complete carapace) length 0.51 mm., height 0.23 mm., thickness 0.22 m.; paratype (complete carapace) length 0.53 mm., height 0.28 mm., thickness 0.24 mm.

Occurrence: All type specimens were collected from Recent beach sand from Loc. 1.

Remarks: Two forms are recognizable in this species. One has an inflated posterocentral area and rather elongate in shape. This difference is especially prominent in dorsal view. At first I believed that the inflated form might be a female; however, according to G. O. Sars (1925) the male form of Cytherura intumescens has a more inflated posterocentral surface than the female form. Perhaps this is due to the very large copulative appendages.

Cytherura skippa Hanai, n. sp.

Pl. VI, Figs. 6 a-b.

Description: Carapace elongate, oblong, anterior margin rounded with about five small crenulations, dorsal and ventral margins long parallel, posterior caudal process prominent, located above mid-height and up-turned. Surface ornamented by primary strong and straight ridges. Anterior marginal dorsal and ventral ridges prominent. Longitudinal ridge running posteriorly from middle of anterior margin obscured in central area where longitudinal ridge is broken into reticulate areas. In posterodorsal area ridges make a prominent triangular pattern. Open areas not smooth. Hinge long and straight. Anterior and posterior teeth of right valve not well developed; median element crenulate, especially in posterior half. Character of marginal area typical of genus. Adductor muscle scars not observable. In anterior view, carapace sub-hexagonal with flat dorsal

and ventral surfaces. In dorsal view, carapace oblong with sharp anterior end and prominent handle-like posterior projection of caudal process.

Dimensions: Holotype (complete carapace) length 0.32 mm., height 0.14 mm., thickness 0.14 mm.

Occurrence: The type specimens were obtained from Recent beach sand from Loc. 3, where they are rare.

Remarks: The New Zealand species described by Hornibrook as Cytherura costellata Brady, which is somewhat different from Brady's original figure in the Challenger Report, has close relationship to this species. However, the surface ornamentation is not similar to Cytherura costellata of Hornibrook, especially in its posterior area.

Cytherura quadrata Hanai, n. sp.

Pl. VII, Figs. 1 a-b.

Description: Carapace rather thick-box-shaped, a little higher in front than behind. Anterior margin obliquely rounded with about five small crenulations on anteroventral narrowly rounded margin; dorsal and ventral margins nearly straight, almost parallel; posterior caudal process short and blunt, located at mid-height, and pointed posteriorly. Surface ornamented by strong ridges. Ventral ridge prominent, starting at lower part of anterior marginal ridge running posteriorly, arching at middle, and very slightly obscuring posterior part of ventral contact margin in lateral view; it terminates at posteroventral margin where it becomes a blunt projection over posterior margin. Dorsal

ridge less prominent, starting in upper part of anterior marginal ridge, running posteriorly, bordering flat dorsal area, and terminating at posterodorsal corner where it sends two branches downward. Middle ridges starts at anterior margin and terminates in anterocentral area, where prominent vertical ridge connects with it in T-shape. Open area between ridges finely reticulate with fine ridges, and pitted. Hinge straight; arrangement typical of genus. Anterior tooth of right valve small, crenulate. Median element socketed. Posterior tooth represented by one small round projecting tooth at termination of higher ridges of selvage. Adductor muscle scars located slightly anterior to center. Details of muscle scars and characters of marginal area similar to C. miurensis, but sinuation of anterior inner margin at mid-height. In dorsal view, carapace oblong owing to lateral extension of ventral ridges. In anterior view, sub-trapezoidal owing to flat ventral and dorsal areas.

Dimensions: Holotype (complete carapace) length 0.46 mm., height 0.26 mm., thickness 0.22.; paraptye (complete carapace) length 0.41 mm., height 0.22 mm., thickness 0.20 mm.; (complete carapace) length 0.42 mm., height 0.22 mm., thickness 0.21 mm.

Occurrence: All type specimens were collected from Recent beach sand from Loc. 1.

Remarks: This box-shaped species is quite different from typical Cytherura in its outline, but is otherwise similar. Cytherura undata from the north European coast has

close relationship to this species, but is different in outline and ornamentation pattern.

Cytherura subundata Hanai, n. sp.

Pl. VII, Figs. 3 a-d.

Description: Carapace thick subtrapezoidal in lateral outline, highest anterior to middle. Right valve much higher and larger than left. Anterior margin obliquely and narrowly rounded at extremity, with two or three short, angular, tooth-like projections. Dorsal margin nearly straight, gently arched anteriorly and posteriorly; ventral margin nearly straight, slightly obscured by ventral ridge in posterior part. Dorsal and ventral margins nearly parallel. Posterior margin obliquely truncated above and forming a sharply angulated caudal process about mid-height. Posteroventral margin obscured by ventral ridges. Surface ornamented with ridges having rather sharp edges. Ventral ridge starts at anterior margin, runs posteriorly, and terminates at posteroventral corner where it leaves a blunt projection. Ventral ridge sharp edged especially in posterior half, and sinuous at middle where one ridge branches off obliquely toward posterodorsal corner. Along anterior margin, ventral ridge becomes anterior marginal ridge; runs from anterior margin to anterior cardinal angle where it is sufficiently high to obscure contact margin. It continues to run along dorsal margin and terminates at posterior caudal process in right valve; in left valve it becomes obscure along the dorsal margin in lateral view. Eye spot round and dis-

tinct, giving rise to a ridge below, which changes direction at mid-height in L-shape and connects with anterior margin. A strong hook-shaped ridge appears in posterodorsal area. Open areas ornamented by fine reticulation. Hinge arrangement typical of genus. Flange, which develops above actual hingement in the right valve, modified by a strong ridge parallel to it making a deep groove between. Details of hingement and marginal area similar to those of C. quadrata Hanai. Adductor muscle scars typical of genus. In dorsal view, sub-rhombic owing to lateral expansion of the ventral ridges. In anterior view, sub-trapezoidal with dorsal area of right valve projected. Ventral area flat and sub-rhombic in ventral view.

Dimensions: Holotype (a right valve) length 0.63 mm., height 0.35 mm.; paratype (a left valve) length 0.65 mm., height 0.36 mm.; (a right valve) length 0.68 mm., height 0.39 mm.; (a left valve) length 0.60 mm., height 0.33 mm.

Occurrrence: The holotype and the two left valves of paratypes were obtained from the Sawane formation (Upper Pliocene) at Loc. 8. The same species also occurs in the Setana formation (Upper Pliocene) in the valley of Loc. 6. One paratype of the right valve is from the Setana formation. (Coll. by Hanai.).

Remarks: The group of Cytherura which is characterized by a thick shell and a grooved flange structure just above the hingement of the right valve, includes the forms most different from typical Cytherura. However, the hinge struc-

ture and the characters of the marginal area are essentially closely related to each other.

Cytherura leptocytheroidea Hanai, n. sp.

Pl. VII, Figs. 2 a-b.

Description: Carapace thick oblong in side view. Anterior margin obliquely rounded; dorsal margin slightly arched, inclined posteriorly; ventral margin nearly straight. Posterior caudal process blunt and inconspicuous, located below mid-height.and down-turned. Surface ornamented with undulated ridges having flat tops. Height of main ridges almost constant; width variable. Anterior marginal ridge starts at lower part of anterior margin, runs upward obliquely in the anterodorsal area and almost reaches the margin, then runs along entire dorsal margin, and terminates in upper half of posterior margin. Eye spot distinct, giving rise downward to an L-shaped ridge terminates at anterior marginal ridge. Ventral ridge starts at lower part of anterior margin, runs posteroventrally, obscuring ventral margin at its middle, turns upward making a rather smooth curve across posteroventral and posterior area of carapace and terminates near posterodorsal corner. Two irregular vertical ridges prominent in central area. Open areas irregularly reticulate with fine ridges. Characters of hingement and flange structure in right valve marginal area and adductor muscle scars similar to those of Cytherura subundata Hanai. In anterior view, oval with flat ventral surface, and more or less projecting dorsal marginal area in right valve.

Dimensions: Holotype (complete carapace) length 0.55 mm., height 0.32 mm., thickness 0.27 mm.; paratype (a right valve) length 0.55 mm., height 0.33 mm.

Occurrence: All type specimens were collected from the Setana formation (Upper Pliocene) in the valley of Loc. 6.

Remarks: This species belongs to the same group as Cytherura subundata Hanai, but in this species the ornamentation of the carapace is more complicated.

Genus HOWEINA Hanai, n. gen.

Type Species: Howeina camptocytheroidea Hanai, n. sp.

Diagnosis: Cytherurinae with arched Cytherura type hingement, but anterior tooth of right valve large and elongated. Ventral surface has slight wing-like ridges. Posterior caudal process indistinct. Inner margin makes modified S-shape along posterior margin. Eye spot indistinct.

Description: Carapace large for this subfamily, ovate in lateral view, right valve slightly overlapping left on dorsal margin, and left overlapping right on ventral margin. Ventral surface has slight wing-like ridges. Caudal process obscure. Nature of marginal area and radial pore canals similar to Cytherura showing modified S-shaped inner margin along posterior margin, but development of inner lamella varies considerably within any one species. Hinge merodont of arched Cytherura type with no crenulations. Hingement of right valve with characteristic large, elongate anterior terminal tooth and small, knob-like posterior terminal tooth at ends of blade-like extension of outer margin of inner

lamella. Above hinge element flange overhangs strongly but does not quite reach teeth, making wide furrow between the teeth and the flange. Hingement of left valve complementary to that of right and similar to that of Cytherura. Median bar and flange over bar almost same height in dorsal view, fused along middle portion. Terminal portion of bar thickened and truncated at ends. Adductor muscle scars consist of four posterior vertical scars and one anterior scar located near center of carapace. Eyes obscure.

Remarks: This genus has close resemblance to Camptocythere from the Jurassic of Germany in its hinge structure, but the character of the marginal area is quite different especially in the nature of the radial pore canals. The closest genus to Howeina is Cytherura. Differences between the two are given in the diagnosis. The genus is named after Dr. Henry V. Howe, Director, School of Geology, Louisiana State University.

Howeina camptocytheroidea Hanai, n. sp.

Pl. VII, Figs. 4 a-c.

Description: Carapace rather thin and ovate in side view, highest at anterior cardinal angle. Anterior margin obliquely rounded, dorsal margin slightly arched. Ventral margin nearly straight. Posterior margin truncated obliquely in upper and lower portions, so as to form an angulation with a rather blunt and round tip. Angulation strong in left valve, and, sometimes, upper half of posterior margin slightly concave outwardly. Surface pitted in posterodorsal to

central area, pits arranged more or less parallel to postero-dorsal margin. Irregular polygonal network of fine ridges developed in anterior and posterior areas. Slight wing-like expansion runs from anteroventral area to posteroventral area where it turns upward making a round curve and continues a short distance. Just posterior to wing-like expansion, carapace is slightly depressed. Ventral area more or less flat and having several fine longitudinal fine ridges which run almost parallel to ventral contact margin. Marginal area, hinge having several fine longitudinal ridges which run almost parallel to ventral contact margin. Marginal area, hinge structure, and the muscle-scar pattern same as for genus. Viewed from above, carapace appears to be slightly compressed anteriorly, thickest a little posterior to middle. In anterior view, carapace subovate with more or less flattened ventral surface, thickest just below mid-height.

Dimensions: Holotype (a right valve) length 0.62 mm., height 0.37 mm.; paratype (a left valve) length 0.64 mm., height 0.35 mm.; (a left valve) length 0.63 mm., height 0.36 mm.; (complete carapace) length 0.64 mm., height 0.39 mm., thickness 0.33 mm.

Occurrence: All type specimens were obtained from the Setana formation (Upper Pliocene) at Loc. 7, where they are abundant.

Genus HEMICYTHERURA Elofson, 1941

Cythere, Cytherura, Cytheropteron auct. (part.)

1941 Cytheropteron (Hemicytherura) Elofson, p. 314.

1952 Cytherura (Hemicytherura) Ruggieri, p. 27.

1952 Hemicytherura Hornibrook, p. 58.

Type Species: Cythere cellulosa Norman, 1865.

Diagnosis: Cytherurinae having subrhomoboidal carapace with narrowly rounded and crenulate anterior margin. Caudal process conspicuous. Surface reticulate. Hinge merodont, of arched Cytherura type. Terminal teeth of right valve knob-like, one or two (rarely three) at termination of more or less poorly developed blade-like ridge of inner lamella. Marginal area well developed, nearly parallel to outer margin. Line of concrescence coincides with inner margin. Radial pore canals gathered into about three groups along anterior margin. Eye spot clear.

Description: Carapace small, subrhomboidal, and lenticular, with conspicuous caudal process. Anterior margin narrowly rounded and crenulate. Right valve larger than left, overlapping left along dorsal margin. However, at caudal process, left valve overlap right. Surface usually reticulate. Marginal area wide, line of concrescence usually coincides with inner margin and runs roughly parallel to outer margin. Radial pore canals few, having a tendency to be grouped. Normal pore canals also few, scattered. Hinge merodont, arched, of Cytherura type. Right valve with small terminal teeth, one or two (rarely three) at each end of blade-like ridge of inner lamella. Median groove between terminal teeth arched and strongly crenulate in its terminal parts. Hinge of left valve consists of arched median bar

which is thickened and crenulate in its terminal portion, and complementary terminal sockets. Median bar projects over flange in dorsal view. Flange projects just above terminal sockets fitting furrow between terminal teeth and overhanging flange of right valve. Adductor muscle scars consist of four vertically arranged posterior scars and one anterior scar. Eye spot clear.

Hemicytherura kajiyamai Hanai, n. sp.

Pl. VI, Figs. 1 a-d.

1913 Cytheropteron videns G. W. Muller, Kajiyama, pp. 4-5, pl. 1., figs. 19-25.

Description: Carapace small, thick, subrhomboidal, in lateral outline highest at middle having four crenulations, dorsal margin high and strongly arched, ventral margin nearly straight, obscured by ventral ridge in its posterior half. Caudal process moderately strong. Ventral ridge makes distinct angulation at posteroventral corner. Surface ornamented by widely open reticulation patterns; anterior two reticulations obliquely elongate, dorsal reticulations more or less fan-shaped, central reticulations round, ventral reticulations elongate along ventral margin. Ridges of reticulations smooth; areas surrounded by ridges ornamented with smaller reticulations, and having one or two small nodes located subcentrally. Along dorsal margin, one ridge runs from anterodorsal corner to caudal process. This ridge projects above dorsal contact margin in right valve. Hinge structure, character of marginal area and adductor muscle-scar pattern

typical of genus. In dorsal view, carapace lenticular; in anterior view, ovate, truncated below where ventral ridge gives distinct angulation. Between ventral ridges of both valves, ventral area nearly flat.

Dimensions: Holotype (complete carapace) length 0.37 mm., height 0.22 mm., thickness 0.18 mm.; paratype (complete carapace) length 0.37 mm.; height 0.22 mm., thickness 0.18 mm.

Occurrence: All types were collected from Recent beach sand from Loc. 1. This species also occurs in the Suganuma sandstone-conglomerate bed of the Oidawara tuffaceous mudstone (Miocene) at Loc. 10.

Remarks: Hemicytherura videns (G. W. Muller) was originally described from the Gulf of Naples as Cytheropteron videns. In 1912, G. W. Muller listed its name again in "Das Tierreich". In 1941, Elofson, in his study of the Skagerak Ostracoda, proposed the name Hemicytherura as a subgenus of Cytheropteron, designating Cythere cellulosa Norman type species. He included Cytheropteron videns in the subgenus Hemicytherura. Rome (1942) reported this species from the environs of Monaco as Cytheropteron videns. Klie (1942) described this species from the Adriatic Sea as Cytheropteron (Hemicytherura) videns. Thus the distribution of Hemicytherura videnc is limited to the Atlantic and Mediterranean regions. No Hemicytherura videns have yet been reported from the Pacific region. Kajiyama's Cytheropteron videns is quite different from the European species in its

ornamentations and outlines, and is here described as a new species. Hemicytherura fereplana Hornibrook has close resemblance to Hemicytherura kajiyamai Hanai n. sp., but has a different reticulation pattern.

Hemicytherura cuneata Hanai, n. sp.

Pl. VI, Figs. 2 a-b.

Description: Carapace small and thick, sub-rhomoidal in lateral outline, highest a little posterior to anterior cardinal angle. Anterior margin obliquely rounded with four crenulations in narrowly lower half. Ventral and dorsal margin nearly parallel; dorsal margin slightly inclined toward posterior. Caudal proecess indistinct, rather obtuse. Posterior caudal area compressed. Eye spot distinct. Dorsal ridges of both valves surround dorsal flattened area. Straight ventral ridge starts at lower part of anterior margin, runs posteriorly bordering ventral flattened area, turns upward at posteroventral corner without distinct angulation and runs into middle of posterocentral area. Surface ornamented with irregular reticulations, of which the central one is large and more or less elliptical in shape; lower boundary of central reticulation makes a distinct ridge and continues straight to anterior margin. Other reticulations essentially formed by radial ridges connecting central reticulations and marginal ridges. Open areas between reticulations ornamented with finer reticulations. Dorsal flattened area ornamented with very fine pits aligned parallel to hinge line. Hinge structure, character of marginal area, and

adductor muscle-scar pattern typical of genus. In dorsal view, carapace lenticular. In anterior view carapace more or less trapezoidal with dorsal ridge projecting in right valve.

Dimensions: Holotype (complete carapace) length 0.37 mm., height 0.23 mm., thickness 0.21 mm.; paratype (complete carapace) length 0.39 mm., height 0.24 mm., thickness 0.21 mm.

Occurrence: All type specimens were obtained from Recent beach sand from Loc. 1.

Remarks: This species shows very close relationship to Hemicytherura pentagona Hornibrook. The minor difference in surface ornamentation suggests that this species may be merely a geographic variant of the New Zealand species. Named for the wedge-shape of this species.

Hemicytherura tricarinata Hanai, n. sp.

Pl. VI, Figs. 3 a-b.

Description: Carapace small and thick, subrhlmoboidal in lateral outline, highest at middle. Anterior margin obliquely rounded. Dorsal margin gently arched, and gradually transitional to posterior margin. Ventral margin straight. Caudal process inconspicuous and rather obtuse. Posterior caudal area compressed. Surface ornamented with three prominent ridges aligned longitudinally, Dorsal ridge starts at middle of anterior margin, runs along dorsal margin, and connects with ventral margin in posterior area. Ventral ridge starts at anterior margin, runs posteriorly nearly parallel to ventral margin obscuring it in

posterior half, and turns upward at posteroventral corner connecting with dorsal ridge. Median ridge runs nearly straight from anterior margin to junction of ventral and dorsal ridges. Two open areas intersected by three vertical ridges forming a coarsely reticulate pattern. Open areas between reticulation have finely granular ornamentation. Some ridges have one or two nodes. Hinge structure, character of marginal area and adductor muscle-scar pattern typical of genus. In dorsal view, carapace lenticular. In anterior view, carapace sub-trapezoidal, with dorsal ridge of right valve projecting above contact margin. Ventral area between more or less alar ridges of both valves nearly flat.

Dimensions: Holotype (complete carapace) length 0.39 mm., height 0.22 mm., thickness 0.18 mm.; paratype (complete carapace) length 0.37 mm., height 0.21 mm., thickness 0.18 mm.

Occurrence: All type specimens were from Recent beach sand from Loc. 4.

Remarks: This species has close resemblance to Hemicytherura quadrazea Hornibrook, but differs in details of ornamentation especially in the posterior part of the median ridge.

Genus CYTHEROPTERON G. O. Sars, 1865 (1866)

Cythere auct. (part.)

1865 (1866) Cytheropteron G. O. Sars, pp. 79-80.

1868 _____ Brady, Int. Obs., p. 124.

1868 _____ Brady, Mon., p. 447.

1874 Cytheropteron Brady, Crossky and Robertson, pp. 201-202.

1878 _____ Brady, Antwerp., p. 402.

1880 _____ Brady, p. 135.

1889 _____ Brady and Norman, p. 207. (Designition of type species).

1894 _____ Lienenklaus, p. 243.

1894 _____ G. W. Muller, p. 300.

1900 _____ Lienenklaus, p. 541.

1900 _____ Namias, p. 110.

1905 _____ Lienenklaus, p. 54.

1909 _____ G. W. Muller, p. 107.

1912 _____ G. W. Muller. p. 273.

1913 _____ Kajiyama, p. 4.

1926 _____ G. O. Sars, p. 223.

1928 _____ Neviani, pp. 35-36.

1929 _____ Alexander, p. 102.

1933 _____ (Cytheropteron) Alexander, pp. 187-190.

1934 _____ _____ Alexander, pp. 229-230.

1936 _____ Van Veen, p 18.

1938 _____ Klie, Tierwelt, pp. 200-201.

1939 _____ Sutton and Williams, p. 573.

1939 _____ (Cytheropteron)

Martin, pp. 176-177.

1941 Cytheropteron Bonnema, p. 26.

1941 _____ (Cytheropteron) Elofson, pp. 313-316.

1941 _____ Tressler, p. 101.

1946 _____ (Cytheropteron) Van den Bold, p. 33.

1946 _____ Stephenson, p. 318.

1948 _____ (Cytheropteron) Kingma, p. 24.

1952 _____ (_____) Hornibrook, p. 52.

1953 _____ (_____) Bowen, p. 280.

Type Species: Cythere latissima Norman, 1865.

Diagnosis: Cytherurinae having wing-like lateral projections and up-turned caudal process. Right valve larger than left. Hinge merodont, of arched Cytheropteron type; right valve has crenulate terminal teeth at each end of hingement and a crenulate groove between, which is obscure in its middle part. Hinge of left valve consists of complementary terminal sockets and crenulate bar between. Marginal area moderately developed with anterior vestibule. Radial pore canals rather simple. Eye spot obscure.

Description: Carapace subrhomboidal to ovate in lateral outline, with upturned and compressed caudal process. Wing-like lateral expansions prominent. Valves unequal, usually right valve slightly larger than left especially along dorsal margin, but left overlaps right in posterior

caudal area. Hinge merodont, of arched Cytheropteron type. Right valve has crenulate terminal teeth at each end of hinge margin. Posterior teeth usually more elongated than anterior and often somewhat up-turned. Well-developed arched flange hangs over actual hinge element. Furrow between teeth and flange of right valve distinct, receiving flange above terminal sockets of left valve. Groove between terminal teeth of right valve strongly crenulate in terminal parts. Corresponding bar of left valve arched and thin in middle part and thickened and strongly crenulate in terminal parts, especially in posterior terminal portion. This bar projects over the edge of the carapace in dorsal view. Marginal area moderately developed, and inner margin nearly parallel to outer margin. Vestibule usually well developed anteriorly. Radial pore canals few, usually simple, sometimes bifurcated. Adductor muscle-scar pattern located in central area but a little below mid-height, and consisting of four vertically arranged posterior scars and one or sometimes two anterior scars.

Cytheropteron sawanensis Hanai, n. sp.

Pl. VIII, Figs. 2 a-c.

Description: Carapace thick, subrhomboidal in lateral outline, highest at middle. Anterior margin obliquely rounded, dorsal margin high and strongly arched, ventral outline obscured by a keeled ala, which is narrowly rounded in its posterior part. Keel continues to anterior margin where it bifurcates. Caudal process pronounced, up-turned. Strong

ridge starts at anterior margin, runs parallel to dorsal margin into posterior caudal area; it is especially strong at anterodorsal and posterodorsal corners. Surface ornamented with coarse punctations aligned vertically. At its middle, ventral ala has a sulcus-like depression on its upper surface. Hinge structure, character of marginal area, and adductor muslce-scars typical of genus. In dorsal view, carapace teardrop shaped with triangular caudal process. In anterior view, carapace triangular.

Dimensions: Holotype (a right valve) length 0.62 mm., height 0.39 mm., thickness 0.25 mm.; paratype (a right valve) length 0.62 mm., height 0.38 mm., thickness 0.25.; (a left valve) length 0.60 mm., height 0.35 mm., thickness 0.21 mm., (a left valve) length 0.59 mm., height 0.35 mm., thickness 0.21 mm.

Occurrence: All type specimens were collected from the Sawane formation (Upper Pliocene) from the cliff at Loc. 8.

Remarks: This species is similar to Cytheropteron fornix Hornibrook in outline and shape of the keeled ala, but is different in other ornamentations such as punctation pattern, strength of the dorsal ridge, and presence of a sulcus-like depression.

Cytheroptern uchioi Hanai, n. sp.

Pl. VIII, Figs. 4 a-b.

Description: Carapace thick, sub-rhomoboidal in lateral outline, highest at middle. Anterior margin obliquely rounded, dorsal margin arched and moderately high. Antero-

dorsal corner of left valve sinuous. Ventral margin obscured by strong, blunt, and more or less rounded ala, extending from anterior margin and having a pit at its middle. Caudal process rather broad, truncated at its tip. Surface nearly smooth with some punctations in central part. At least three very fine, vertical ridges visible in central area. Along edge of ala are two or three very fine ridges running parallel to edge. Hingement, character of the marginal area and the adductor muscle scars typical of genus. Radial pore canals do not reach anterior margin. In dorsal view, carapace spade-shaped with a rather small triangular caudal process. In anterior view the carapace is triangular.

Dimensions: Holotype (a right valve) length 0.63 mm., height 0.43 mm., thickness 0.27 mm.; paratype (a right valve) length 0.61 mm., height 0.46 mm., thickness 0.25 mm.; (a left valve) length 0.60 mm., height 0.41 mm., thickness 0.22 mm.; (a left valve) length 0.67 mm., height 0.43 mm., thickness 0.26 mm.

Occurrence: All type specimens were collected from Cucullaea zone the Hegi Formation (Pliocene) at Loc. 9.

Remarks: The lateral and dorsal outlines of this species have some resemblance to Cytheroptern "sp. A" of Kingma.

Cytheropteron rare Hanai, n. sp.

Pl. VIII, Figs. 3.

Description: Carapace somewhat thin, sub-rhomoboidal in lateral outline. Anterior margin obliquely rounded, dor-

sal and ventral margins sub-parallel. A strong, sharp-edged, more or less rounded ala, starts in anteroventral area, runs posteriorly making a gently convex curve laterally and turns up to mid-height without making any distinct corner in posteroventral area. Ventral margin obscured by ala in posterior half. Posterior margin obliquely rounded upward owing to inconspicuous, very blunt, up-turned caudal process. Surface sculptured by vertical and irregularly arranged ridges in posterior half; ridges connected by longitudinal ridges so as to make vertically elongate reticulations. Anterior half of carapace has smooth surface. Ala has a prominent depression at middle of upper surface. Hinge structure slightly longer and more fragile than typical Cytheropteron. Adductor muscle scars and marginal area typical of genus. In anterior view, carapace subtriangular with somewhat inflated lateral outline. Viewed dorsally, carapace appears spade-shaped. Dorsal flat surface ornamented with longitudinal ridges and a series of small pits.

Dimensions: Holotype (a left valve) length 0.64 mm., height 0.38., thickness 0.28 mm.

Occurrence: The type specimen was obtained from the Sawane formation (Upper Pliocene) from the cliff at Loc. 8.

Remarks: The vertically elongate pattern of reticulation on the posterior part of the carapace is characteristic of this species. The somewhat fragile carapace indicates slight deviation of this species from typical Cytheropteron.

Cytheropteron miurensis Hanai, n. sp.

Pl. VIII, Figs. 1 a-b.

Description: Carapace small, thick, sub-rhomboidal in lateral outline, highest at middle. Anterior margin obliquely and strongly rounded, dorsal margin strongly arched in ant anterior half and strongly concave in posterior half. Posterior half. Posterior margin angular making nearly a right angle with dorsal margin. Caudal process moderately strong. Ventral margin obscured by ala; posterior cardinal angle distinct. Ala very blunt. Blunt ridge runs along dorsal margin. Surface ornamented with numerous punctations arranged in more or less vertical rows. Punctations coarser in posterior half of carapace. In posterocentral area, punctations connected vertically forming vertical rows of punctate grooves. Marginal area moderately broad, broadest at anterior and posterior ends. Radial pore canals not numerous, and bifurcated. Vestibule poorly developed along anterior margin, broadest at anteroventral margin. Hinge line curves in S-shape in interior view. Hingement of right valve consists of anterior and posterior teeth and intermediate crenulate groove. Intermediate element subdivided into three sections; short anterior groove with three large crenulations; median arched non-grooved area; and concave posterior groove with six large crenulations, of which anterior three are stronger serrated and shallow, and posterior three are connected and deep. Hingement of left valve complementary to right, consisting of anterior and posterior sockets and intermediate crenulate ridges. Intermediate ele-

ment subdivided into three sections; anterior crenulate ridge, arched high and sharp intermediate ridge, and posterior crenulate ridge which consists of anterior three strongly serrated crenulations and posterior more or less fused crenulations. High arched median ridge fits just under strongly arc arched and projecting flange of right valve. Adductor muscle scars located anteroventral to center, and consist of four vertically arranged elongate scars with an obliquely elongated scar in front. In dorsal view, carapace triangular with caudal process projecting. In anterior view, carapace triangular truncated above by small flat dorsal area.

Dimensions: Holotype (complete carapace) length0.49 mm., height 0.32 mm., thickness 0.34 mm.

Occurrence: The holotype occurs in Recent shell sand at Loc. 1, where this species is rare.

Remarks: This species is closely related to Cytheropteron dividentum Hornibrook. However, the Japanese species does not possess a projection in the lower half of the posterior margin and the punctations are much more numerous than in C. dividentum.

Genus KOBAYASHIELLA Hanai, n. gen.

Type Species: Kobayashiella hyalinosa Hanai, n. sp.

Diagnosis: Carapace fragile and nearly transparent, shaped like Cytheropteron,with sharp, pointed ala. Caudal process turned downward. Hingement of right valve consists of anterior, large, knob-like split tooth, median finely crenulate furrow, and posterior tooth which consists of a

row of small, elongate, knob-like teeth. Anterior tooth has a step-like projection just below it. Median furrow has a shallow depression at anterior termination, and has no distinct interior raised margin except at middle where anterior finely crenulate and arched part turns into straight, more or less coarsely crenulate part. Inside of shell swells up so as to form elongate tooth-like projection at middle of interior margin of furrow. Hingement of left valve complementary, except anterior socket which has a prominent anti-slip tooth-like projection on its inner margin. Character of marginal area and adductor muscle scars similar to those of Cytheropteron.

Description: Carapace sub-triangular due to development of down-turned caudal process. On anterior end, a prominent flaring outer margin turns outward. Surface smooth and glossy. Adductor muscle-scars visible from outside, consisting of a vertical row of four scars with one scar in front and at least two scars above anterior scar. Marginal area moderately developed, with anterior vestibule. Radial pore canals few, about ten in anterior margin and three in posterior margin, not extending the width of the duplicature on anterior margin. Normal pores not numerous. Hingement of genus as defined in diagnosis. Right valve larger than left, overlapping it distinctly in posterior part of dorsal margin.

Remarks: This genus is closely related to the genus Cytheropteron, but it is clearly different in hinge struc-

ture, especially in anterior tooth-and-socket structure. The inner swelling of the middle part of the median furrow in right valve and corresponding depressions of the median bar in the left valve are also characteristic of this genus. It is named after Dr. Teiichi Kobayashi, Professor of Geology, University of Tokyo, under whose guidance the writer commenced the study of Ostracoda.

Kobayashiella hyalinosa Hanai, n. sp.

Pl. VIII, Figs. 5 a-b.

Description: Carapace thin, fragile and sub-transparent, sub-triangular in lateral outline. Anterior margin obliquely rounded, dorsal margin moderately arched and inclined posteriorly, ventral margin, moderately convex, inclined upward slightly. Point of ala obscures ventral margin for short distance in posterior part. Posterior caudal process large and blunt, directed slightly downward and truncated at posterior end. Ala prominent; outer border of ala gently convex and keeled; ventrolateral angle of ala distinct and having a sharp spine pointing posterolaterally. Upper surface of ala has a small but deep cut parallel to margin. Surface smoothaand glossy. Hinge structure, nature of the marginal area, and adductor muscle-scars same as for genus. In anterior view, carapace sub-triangular. Viewed ventrally, carapace appears in arrow-head shape with more or less convex anterolateral margin and concave posterolateral margin. Ala has a pit on ventral side.

Dimensions: Holotype (a right valve) length 0.67 mm.,

height 0.39 mm., thickness 0.21 mm.; paratype (a right valve) length 0.65 mm., height 0.39 mm., thickness 0.19 mm.; (left valve) length 0.70 mm., height 0.42 mm., thickness 0.21 mm.; (a left valve) length 0.66 mm., height 0.39 mm., thickness 0.21 mm.

Occurrence: All type specimens were collected from the Sawane formation (Upper Pliocene) from the cliff at Loc. 8, where they are common.

Remarks: The specific trivial name is derived from Greek, hyalinos, meaning glassy.

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Explanation of Plate I

X 88

Figs. 1 a,b, Callistocythere nipponica Hanai, n. sp.

1 a, right valve view of holotype (CA 2541).

1 b, left valve view of holotype.

Figs. 2 a,d, Callistocythere hayamensis Hanai, n. sp.

2 a, right valve view of allotype (CA 2549).

2 b, left valve view of allotype.

2 c, right valve view of holotype, (CA 2548).

2 d, left valve view of holotype.

Figs. 3 a,d, Callistocythere undulatofacialis Hanai, n. sp.

3 a, right valve view of allotype (CA 2563).

3 b, left valve view of allotype.

3 c, right valve view of holotype (CA 2562).

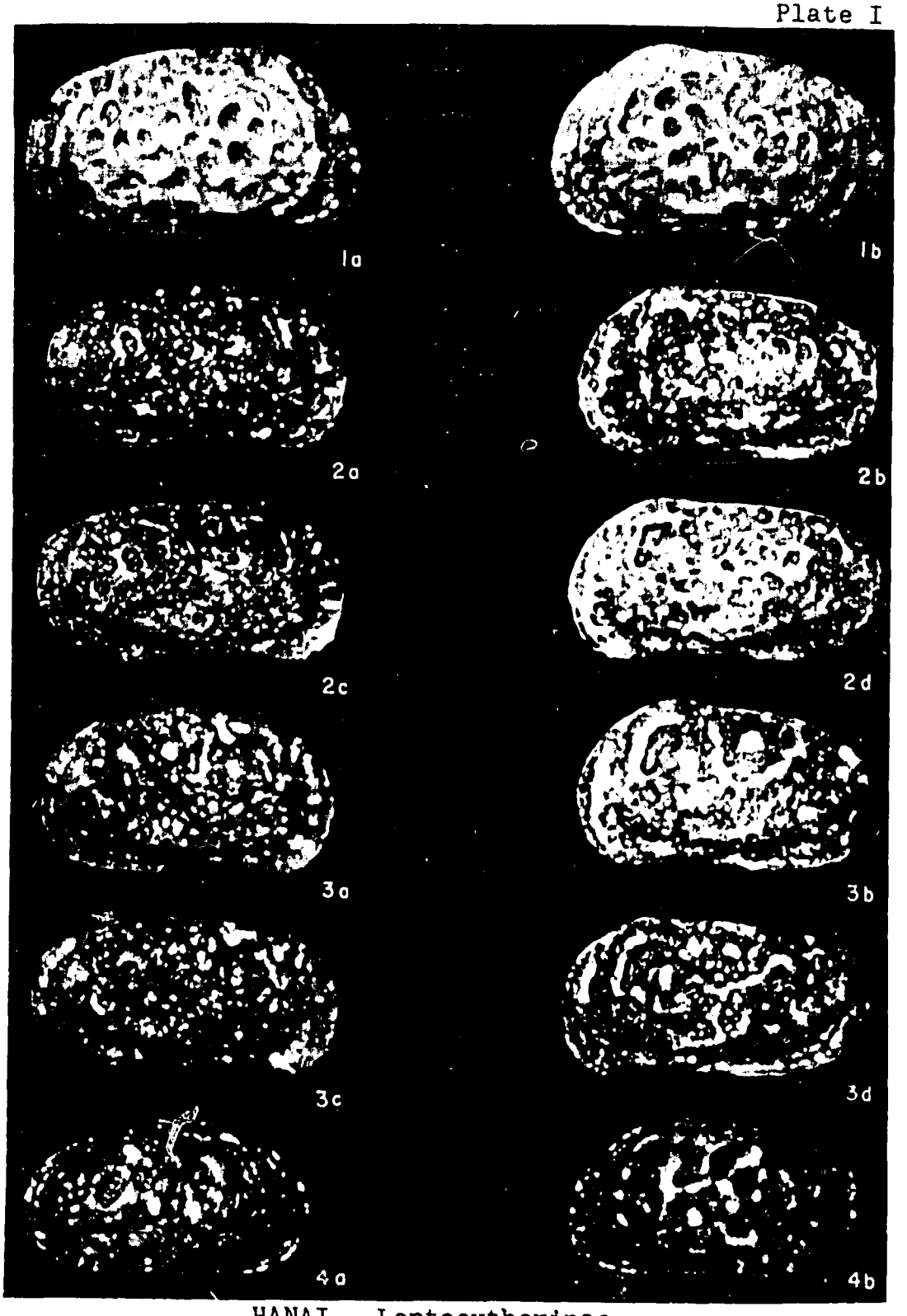
3 d, left valve view of holotype.

Figs. 4 a,b, Callistocythere alata Hanai, n. sp.

4 a, right valve view of holotype (CA 2547).

4 b, left valve view of holotype.

Plate I



HANAI - Leptocytherinae

EXPLANATION OF PLATE II

X 88

Figs. 1, a,d Callistocythere undata Hanai, n. sp.

1 a, right valve view of holotype (CA 2554).

1 b, left valve view of holotype.

1 c, right valve view of allotype (CA 2555).

1 d, left valve view of allotype.

Figs. 2, a,d Callistocythere reticulata Hanai, n. sp.

2 a, right valve view of holotype (CA 2543).

2 b, left valve view of holotype.

2 c, right valve view of allotype (CA 2544).

2 d, left valve view of allotype.

Figs. 3, a,d Callistocythere rugosa Hanai, n. sp.

3 a, right valve view of holotype (CA 2550).

3 b, left valve view of holotype.

3 c, right valve view of allotype (CA 2551).

3 d, left valve view of allotype.

Figs. 4, a,e Callistocythere subjaponica Hanai, n. sp.

4 a, right valve view of holotype (CA 2566).

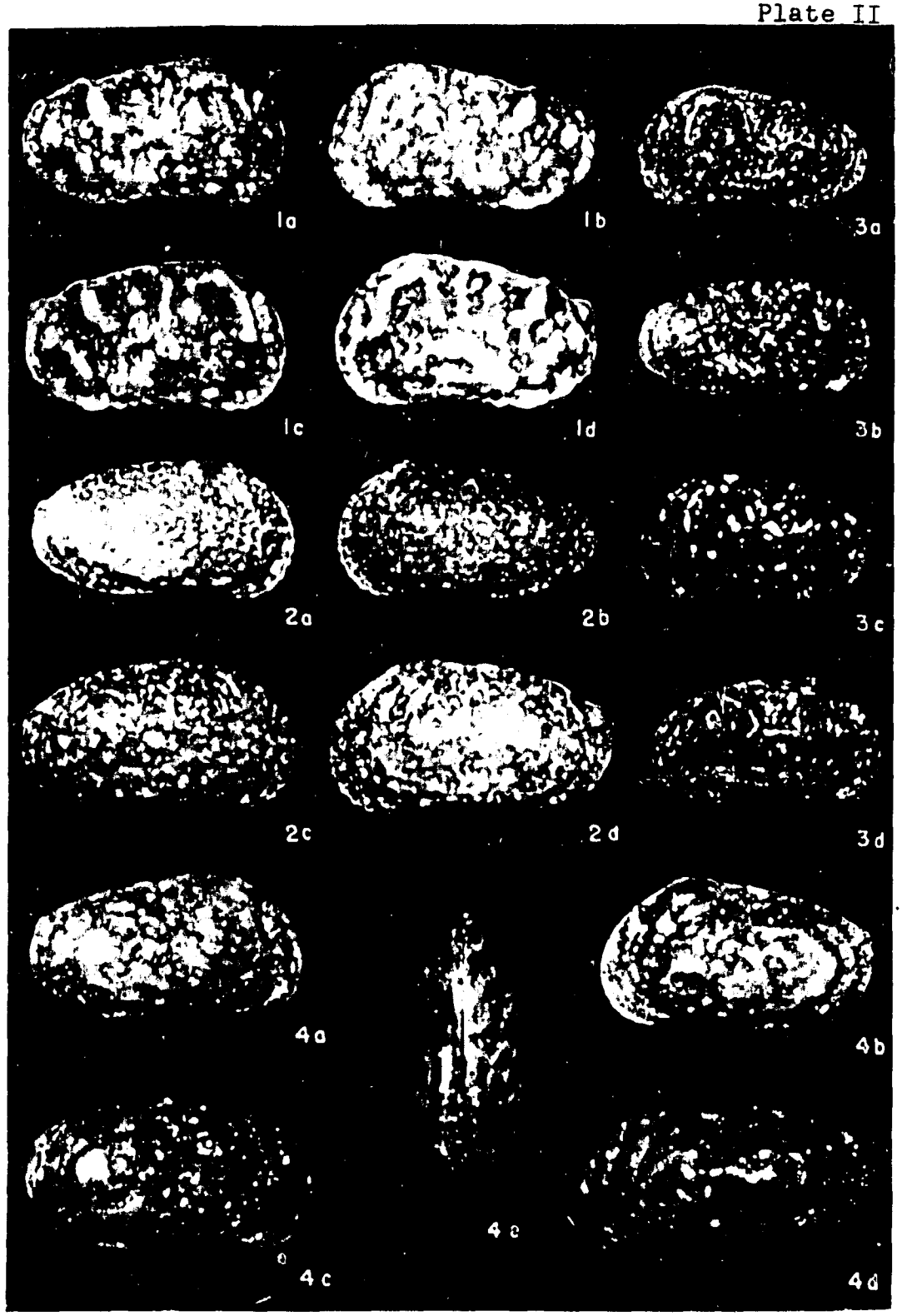
4 b, left valve view of holotype.

4 c, right valve view of allotype (CA 2567).

4 d, left valve view of allotype.

4 e, dorsal view of holotype.

Plate II



HANAI - Leptocytherinae

EXPLANATION OF PLATE III

X 88

Figs. 1, a,e, Tanella miurensis Hanai, n. sp.

1 a, right valve view of holotype (CA 2582).

1 b, left valve view of holotype.

1 c, right valve view of allotype (CA 2583).

1 d, left valve view of allotype.

1 e, dorsal view of allotype.

Figs. 2, a,g Callistocythere japonica Hanai, n. sp.

2 a, right valve view of holotype (CA 2572).

2 b, left valve view of holotype.

2 c, right valve view of allotype (CA 2573).

2 d, left valve view of allotype.

2 e, right valve view of paratype (CA 2575).

2 f, left valve view of paratype (CA 2575).

2 g, dorsal view of holotype.

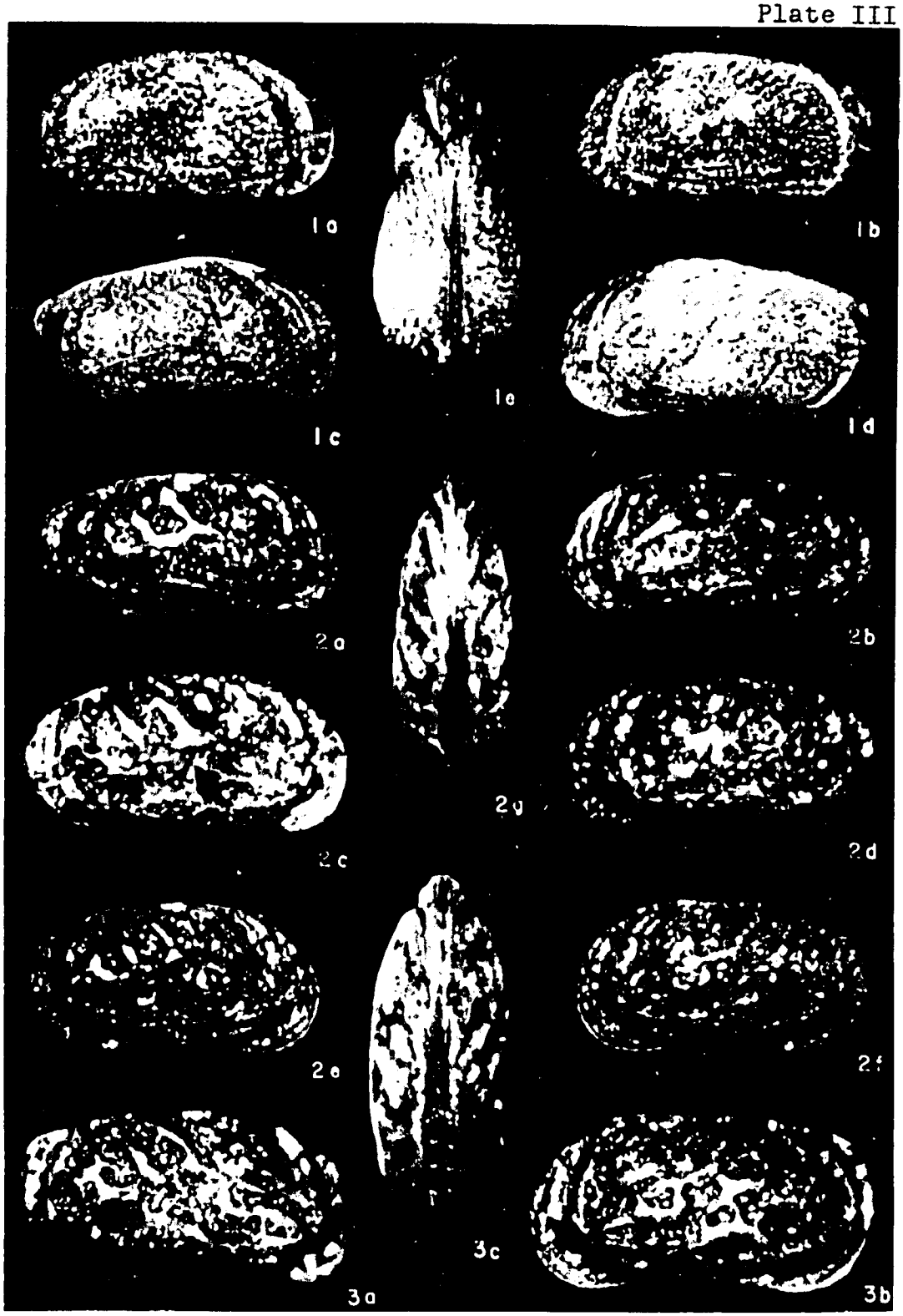
Figs. 3, a,c Callistocythere japonica uranipponica Hanai n. subsp.

3 a, right valve view of holotype (CA 2576).

3 b, left valve view of holotype.

3 c, dorsal view of holotype.

Plate III



HANAI - Leptocytherinae

EXPLANATION OF PLATE IV

X 88

Figs. 1, a,e, Microcallistocythere minor Hanai, n. sp.

1 a, right valve view of paratype (CA 2580).

1 b, left valve view of paratype (CA 2587).

1 c, right valve view of holotype (CA 2585).

1 d, left valve view of holotype.

1 e, dorsal view of holotype.

Figs. 2, a,c, Callistocythere pumila Hanai, n. sp.

2 a, left valve view of paratype (CA 2579).

2 b, right valve view of holotype (CA 2578).

2 c, right valve view of paratype (CA 2581).

Figs. 3, a,b, Callistocythere setanensis Hanai, n. sp.

3 a, left valve view of holotype (CA 2570).

3 b, right valve view of paratype (CA 2571).

Figs. 4, Callistocythere nipponica Hanai, n. sp.

4, dorsal view of holotype (CA 2541).

Figs. 5, Callistocythere alata Hanai, n. sp.

5, dorsal view of holotype (CA 2547).

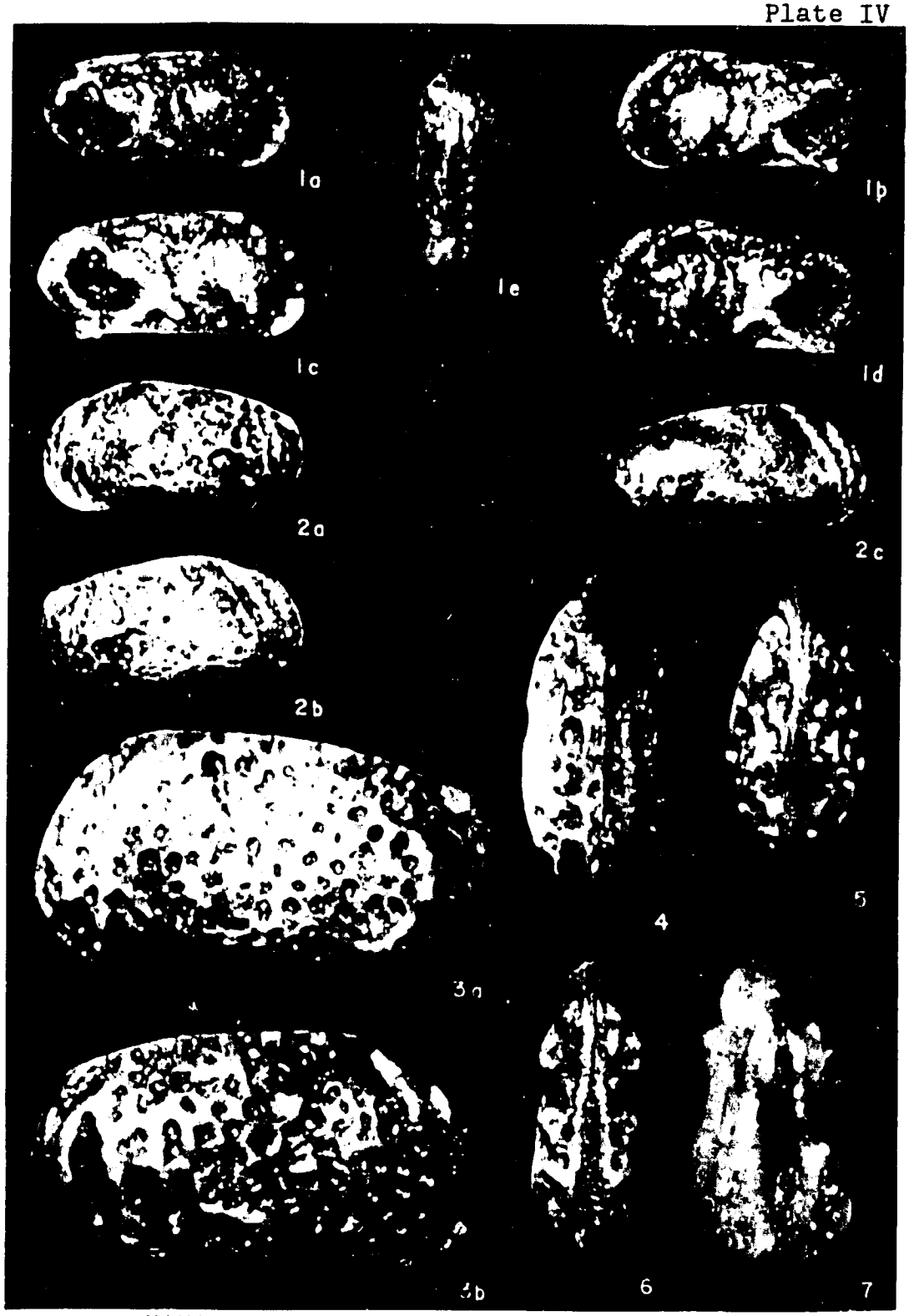
Figs. 6, Callistocythere undulatofacialis Hanai, n. sp.

6, dorsal view,of holotype (CA 2562).

Figs. 7, Neocythere quadrangulata Hanai, n. sp.

7, dorsal view of holotype (CA 2594).

Plate IV



HANAI - Leptocytherinae & "Toulminiinae"

EXPLANATION OF PLATE V

X 88

Figs. 1, a,e "Toulminia" japonica Hanai, n. sp.

1 a, right valve view of holotype (CA 2589).

1 b, left valve view of holotype.

1 c, right valve view of allotype (CA 2590).

1 d, left valve view of allotype.

1 e, dorsal view of paratype (CA 2592).

Figs. 2, a,b "Toulminia" hokkaidoana Hanai, n. sp.

2 a, left valve view of holotype (CA 2593).

2 b, right valve view of holotype.

Figs. 3, a,b Neocythere quadrangulata Hanai, n. sp.

3 a, left valve view of holotype (CA 2594).

3 b, right valve view of holotype.

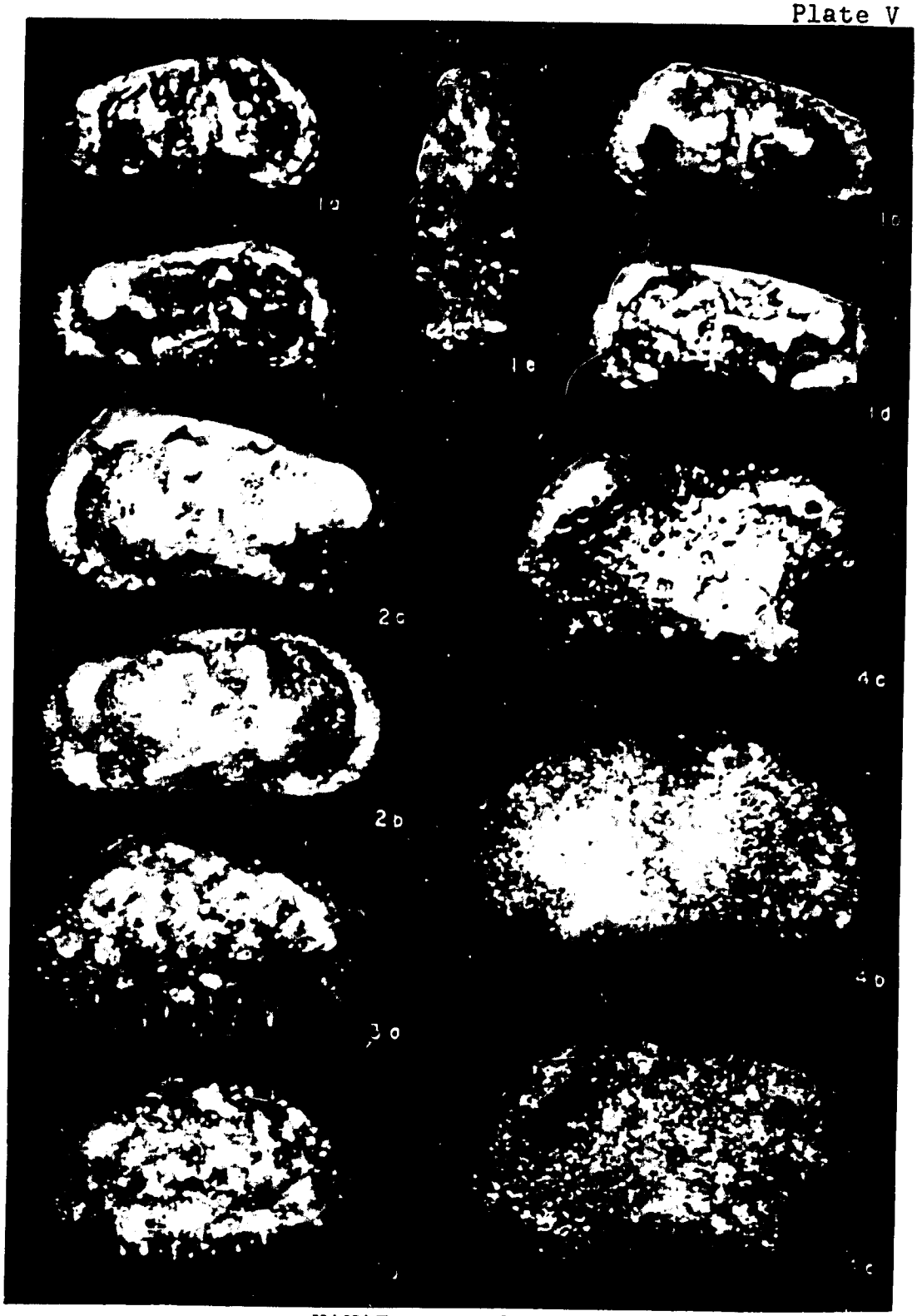
Figs. 4, a,c Neocythere pseudoamphidonta Hanai, n. sp.

4 a, left valve view of holotype, (CA 2596).

4 b, right valve view of paratype, (CA 2597).

4 c, left valve view of paratype (CA 2597).

Plate V



HANAI - "Toulminiinae"

EXPLANATION OF PLATE VI

X 88

Figs. 1, a,c Hemicytherura kajiyamai Hanai, n. sp.

1 a, right valve view of holotype (CA 2616).

1 b, right valve view of paratype (CA 2617).

1 c, left valve view of paratype.

1 d, right valve view of a specimen from Loc. 10 (CA 2618).

Figs. 2, a,b Hemicytherura cuneata Hanai, n. sp.

2 a, right valve view of holotype (CA 2619).

2 b, left valve view of paratype (CA 2620).

Figs. 3, a,b Hemicytherura tricarinata Hanai, n. sp.

3 a, right valve view of holotype (CA 2621).

3 b, left valve view of paratype (CA 2622).

Figs. 4, a,d Cytherura miurensis Hanai, n. sp.

4 a, right valve view of holotype (CA 2600).

4 b, left valve view of holotype.

4 c, right valve view of paratype (CA 2601).

4 d, left valve view of paratype (CA 2601).

Figs. 5, a,d Cytherura tetragona Hanai, n. sp.

5 a, right valve view of paratype (CA 2599).

5 b, left valve view of paratype (CA 2599).

5 c, right valve view of holotype (CA 2598).

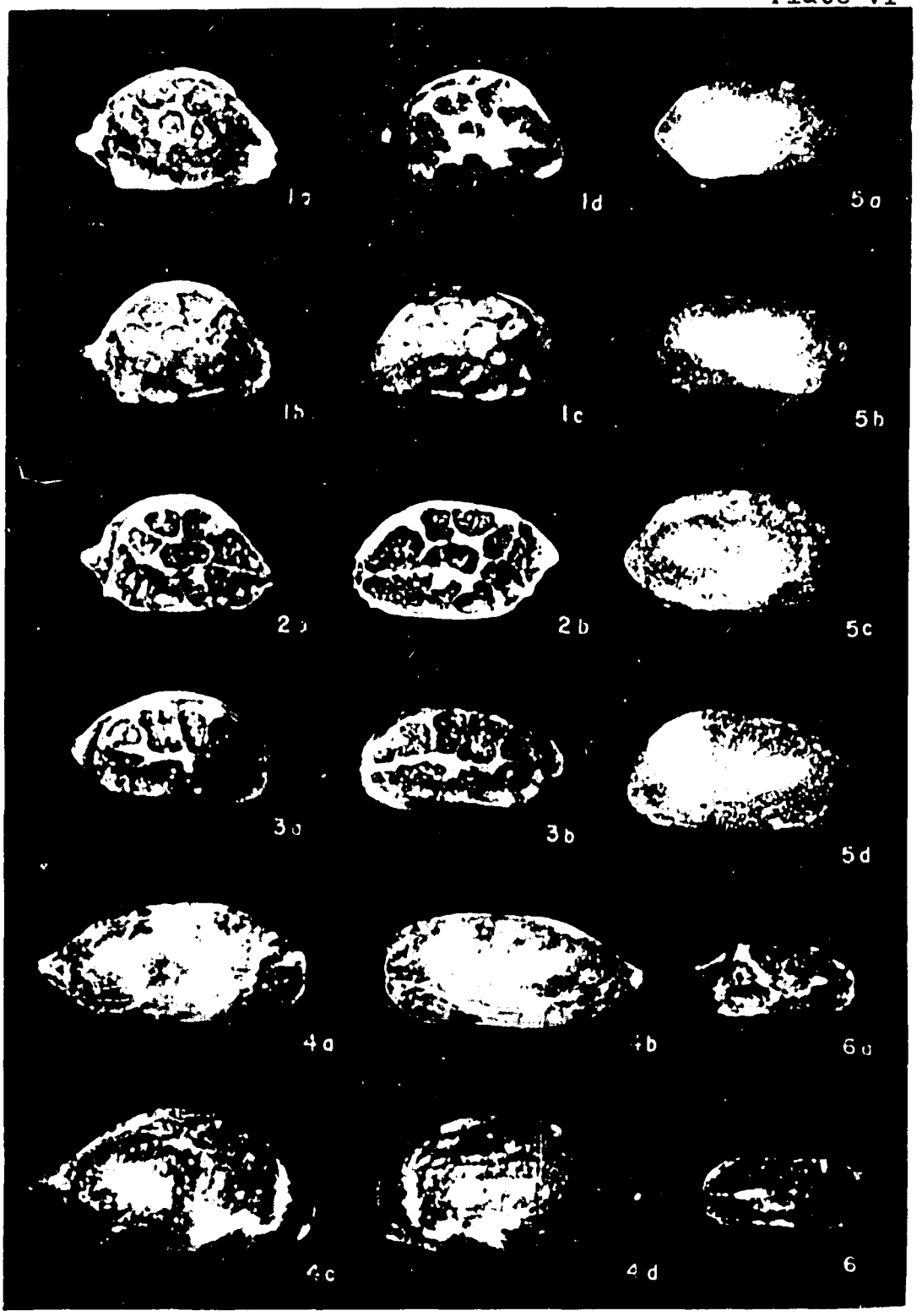
5 d, left valve view of holotype.

Figs. 6, a,b Cytherura skippa Hanai, n. sp.

6 a, right valve view of holotype (CA 2602).

6 b, left valve view of holotype.

Plate VI



HANAI - Cytherurinae

EXPLANATION OF PLATE VII

X 88

Figs. 1, a,b, Cytherura quadrata Hanai, n. sp.

1 a, right valve view of holotype (CA 2603).

1 b, left valve view of holotype.

Figs. 2, a,b Cytherura leptocytheroidea Hanai, n. sp.

1 a, right valve view of paratype (CA 2611).

1 b, left valve view of holotype (CA 2610).

Figs. 3, a,d Cytherura subundata Hanai, n. sp.

1 a, right valve view of holotype (CA 2606).

1 b, left valve view of paraptye (CA 2609).

1 c, right valve view of paratype (CA 2608).

1 d, left valve view of paratype (CA 2607).

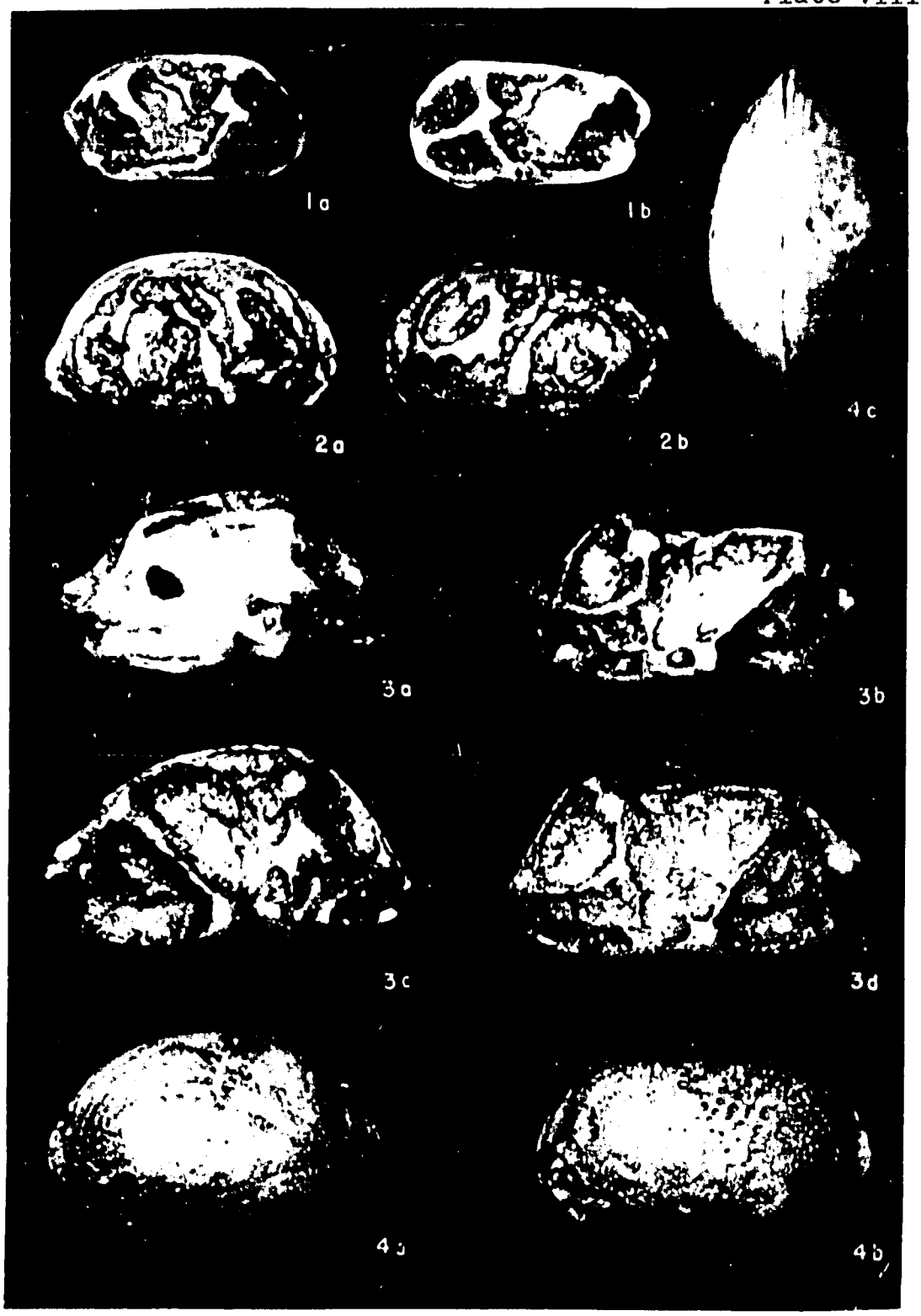
Figs. 4, a,c Howeina camtocytheroidea Hanai, n. sp.

4 a, right valve view of holotype (CA 2612).

4 b, left valve view of paratype (CA 2614).

4 c, dorsal view of paratype (CA 2615).

Plate ~~VIII~~



HANAI - Cytherurinae

EXPLANATION OF PLATE VIII

X 88

Figs. 1, a,b *Cytheropteron miurensis* Hanai, n. sp.

1 a, right valve view of holotype (CA 2632).

1 b, left valve view of holotype.

Figs. 2, a,c *Cytheropteron sawanensis* Hanai, n. sp.

2 a, right valve view of holotype (CA 2633).

2 b, left valve view of paratype (CA 2626).

2 c, right valve view of paratype (CA 2624).

Figs. 3, *Cytheropteron rare* Hanai, n. sp.

3, left valve view of holotype (CA 2631).

Figs. 4, a,b *Cytheropteron uchioi* Hanai, n. sp.

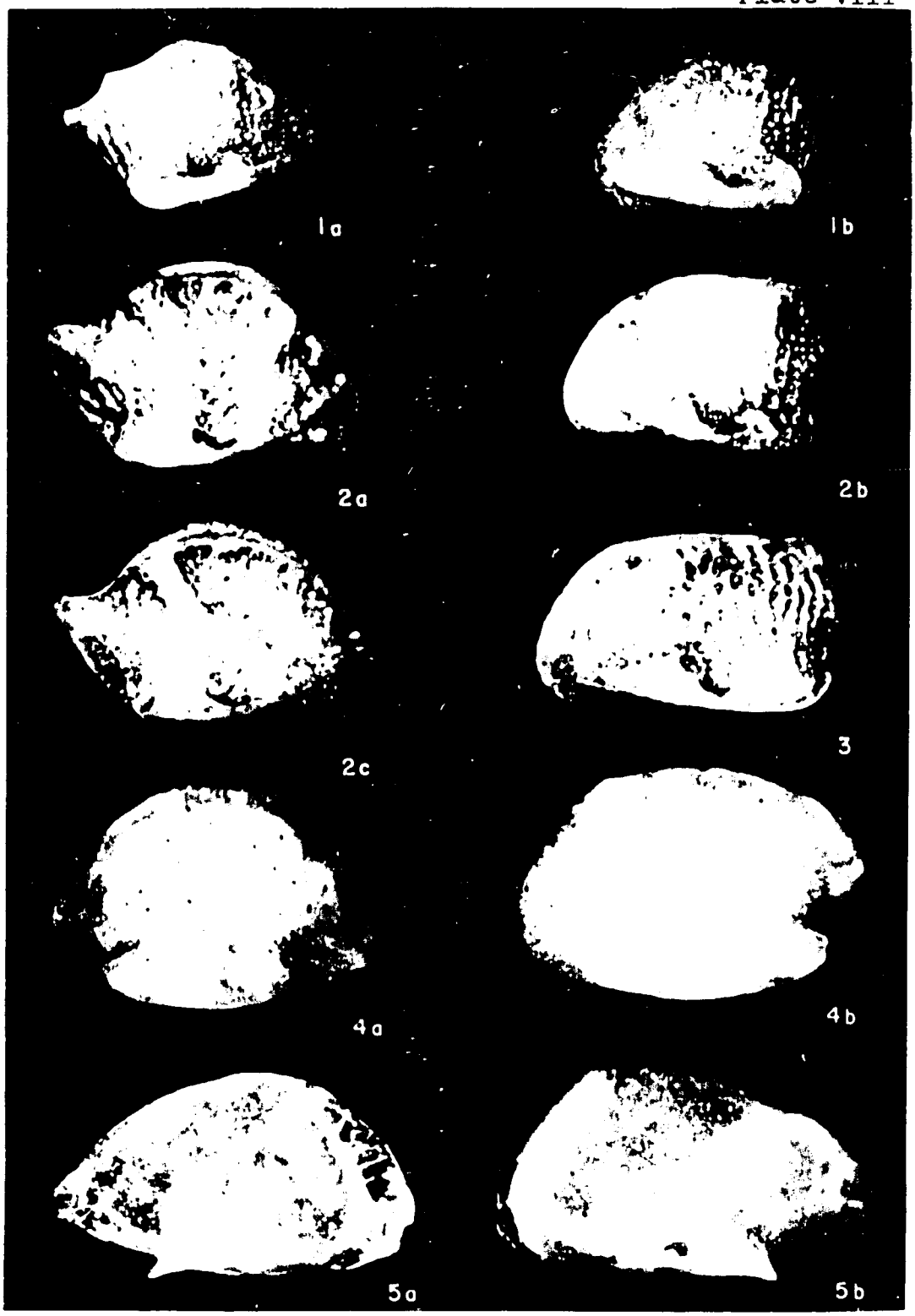
4 a, right valve view of holotype (CA 2627).

4 b, left valve view of paratype (CA 2630).

Figs. 5, a,b *Kobayashiella hyalinosa* Hanai, n. sp.

5 a, right valve view of holotype (CA 2633).

5 b, left valve view of paratype (CA 2635).



HANAI - Cytherurinae

AUTOBIOGRAPHY

Tetsuro Hanai was born in Kanagawa Prefecture, Japan, on March 13, 1924. He completed elementary and middle school work in the experimental school of Tokyo Higher Normal School, and high school work in Hirosaki High School, Aomori Prefecture, Japan. In 1945 he entered the Geological Institute, University of Tokyo, where he started his study of the paleontology of Ostracoda in 1946. After graduation from the University of Tokyo in 1948 with Rigakushi degree, he continued study of Ostracoda on a special research fellowship from the Ministry of Education. In 1950 he was appointed instructor by the Ministry of Education to assist in teaching and research work in the section of sedimentology, Geological Institute, University of Tokyo. He was given a leave of absence from the University of Tokyo, and in 1953, on a Fulbright grant, he came to the United States for further study of ostracode paleontology at Louisiana State University.

On January 24, 1953, he married Michiko Shimada of Setagaya, Tokyo. They have a son, Tatsuya Hanai.

EXAMINATION AND THESIS REPORT

Candidate: Tetsuro Hanai

Major Field: Geology

Title of Thesis: STUDIES ON THE OSTRACODA FROM JAPAN: I SUBFAMILIES LEPTOCYTHERINAE, N.SUBFAM., "TOULMININAE", N.SUBFAM., AND CYTHERURINAE G.W.MÜLLER.

Approved:

H. V. Howe
Major Professor and Chairman

Richard J. Russell
Dean of the Graduate School

EXAMINING COMMITTEE:

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Date of Examination:

May 12 1956